III

ANNUAL REPORT

NAVAJO DISTRICT

For the Year Ending June 30, 1936

United States Department of Agriculture
Soil Conservation Service

III

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For the Year Ending June 30, 1936

United States Department of Agriculture
Soil Conservation Service

Gallup, New Mexico
Box 1151
July 9, 1936

Mr. H. G. Calkins
Regional Conservator
Soil Conservation Service
Box 1314
Albuquerque, New Mexico

Dear Mr. Calkins:

There is submitted herewith the Annual Report for "The Navajo District" of the Soil Conservation Service for the year ending June 30, 1936.

Respectfully,

F. D. Matthews
Navajo District Manager

FDM:MH
inc.

Gallup, New Mexico
Box 1151
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F. D. Matthews
Navajo District Manager

FDM:MH
inc.

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TABLE OF CONTENTS

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PART I

LAND MANAGEMENT DISTRICT MAP
NAVAJO & ZUNI RESERVATION

NAVAJO DISTRICT

DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H. H. BENNETT - DIRECTOR

REFERENCE Aerial Photos Field Surveys

SUBMITTED	APPROVED
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COMPILED	TRACED	CHECKED	DATE	
Benton	Benton	D B M	6-30-36	N-400

Plate I

The selection of the Navajo Indian Reservation as one of the original Soil Conservation Service projects was based on the fact that this area was outstanding in its need for proper land management and would make an ideal demonstration area, in that the land was in an advanced stage of depletion as regards both soil and vegetation; the Navajo tribe with a rapidly increasing population was dependent for its livelihood on the productivity of the land; the area contributed heavily to the silt load of the Colorado River; it was representative of existing conditions in the southwest and the entire area was Federally controlled, which permitted the establishment of a project through a working agreement between the Bureau of Indian Affairs and the Soil Conservation Service.

The Navajo Indian Reservation, comprising approximately seventeen million acres, includes portions of three states, Arizona, New Mexico, and Utah, but in itself is not a complete watershed unit. In carrying out the program for the Navajo Reservation, a number of small watersheds were selected as working areas and twelve of those are now functioning as demonstrations of proper land management.

With the general Reservation surveys practically complete, the Reservation has been divided into eighteen tentative land management units, basing the determination of the boundaries of each on physiographic, chapter, and usage lines. Note Plate 1 for location and numbering. Studies and plans for unit number fourteen (Five Chapters) are complete and the application of the plans is now underway. Studies are being made on units eight, eleven, and seventeen. Each of these units is to be placed in charge of a supervisor who will be the field agent for the Director of land management. Under agreement between the Department of Agriculture and the Department of the Interior, the work of the Indian Service and Soil Conservation Service on the Reservation has been closely integrated through the formation of one land management division, consisting of land management personnel from both Services. The Director of the land management division is the Associate District Manager of the Soil Conservation Service and is responsible to the Indian Service Superintendent and the Navajo District Manager of the Soil Conservation Service.

Region number eight has been divided into a number of complete watershed units, designated "Districts". Under this plan, the Navajo Project became the Navajo District. Approval has been requested to extend the present limits to include the entire San Juan and Little Colorado River watersheds. The arguments used to

The adoption of the Simple Indian Conservation as one of the original Soil Conservation Service projects was based on the fact that this area was particularly in the need for proper land management and would lend to ideal demonstration area. In that the land was in an advanced stage of depletion as regards both soil and vegetation, the Sioux with which a highly interesting population was dependent for its livelihood on the productivity of the land, the area contained heavily on the city land of the Oglala Sioux Tribe, it was representative of climatic conditions in the northwest and the entire area was basically agricultural, which permitted the application of a program through a working agreement between the Bureau of Indian Affairs and the Soil Conservation Service.

The Simple Indian Conservation, comprising approximately seven million acres, includes portions of three states, Nebraska, South Dakota, and Utah, but is largely in and is mostly occupied by Indians. In carrying out the program the Simple Conservation, a number of small watersheds were selected as critical areas and during of these was not feasibility as demonstration of proper land management.

With the general conservation survey practically complete, the Conservation has been divided into eighteen tentative land management units, having the determination of the Department of each as physiographic, climatic, and range types. This plan is for three years and tentative. Studies and plans for each minor farmers (five farmers) are complete and the application of the plans is now underway. Studies are being made on units eight, eleven, and twelve. Each of these units is to be planned in advance of a supervisor who will be the field agent for the director of land management. Under arrangement between the Department of Interior and the Department of the Interior, the work of the Indian Service and Soil Conservation Service on the Reservation has been closely integrated through the formation of one land management district, consisting of land management personnel from both Services. The director of the land management district is the Executive director of the Soil Conservation Service and is responsible to the Indian Service Superintendent and the Simple Tribal Manager of the Soil Conservation Service.

Seven number eight has been divided into a number of conservation units, designated "Tributary". Under this plan, the Simple Project Bureau the Simple Tribal. Approval has been requested to extend the present Tribal to include the entire Sioux and Little Cheyenne River watersheds. The techniques used in

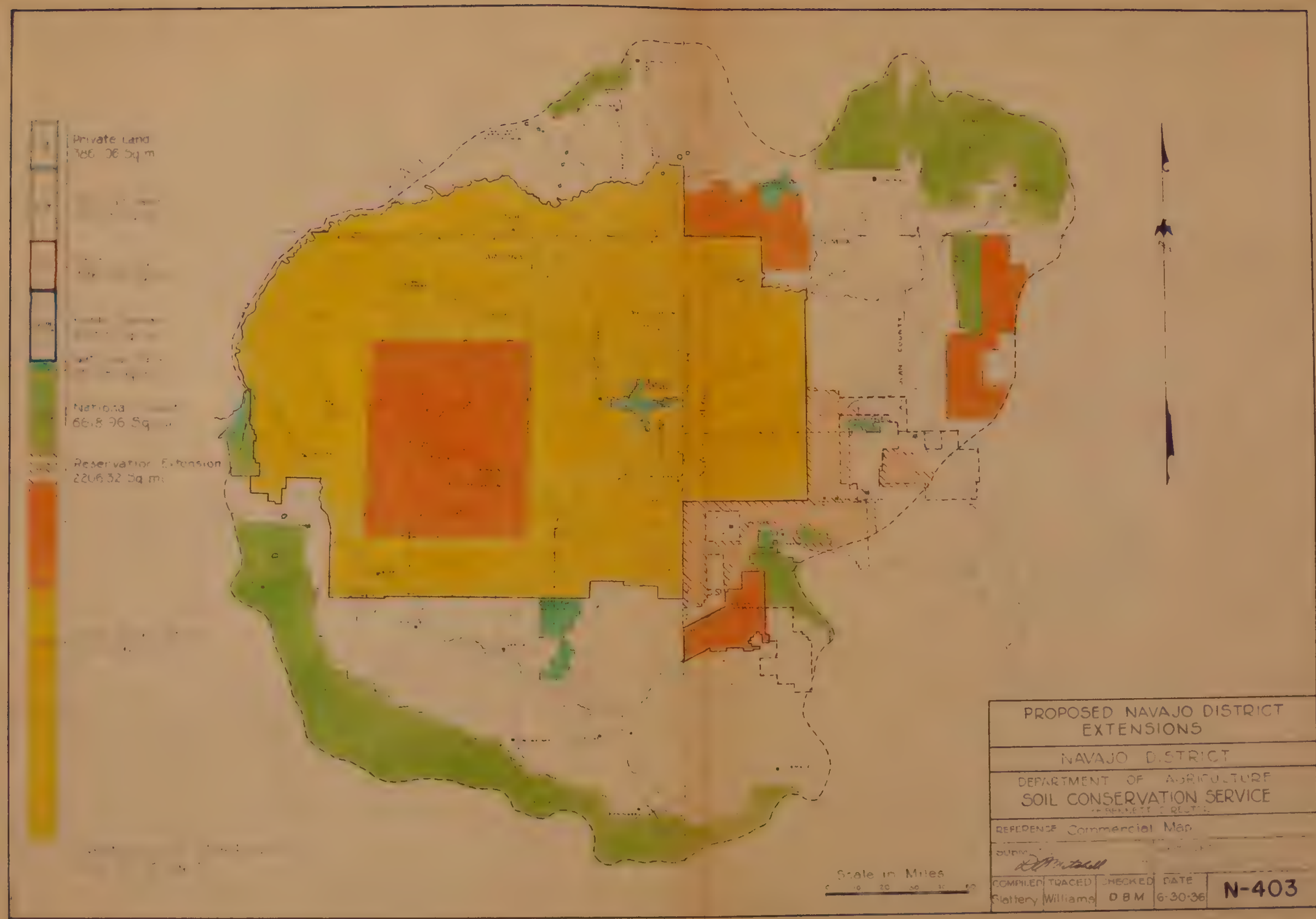

Private Land
386 06 Sq m
Reservation Extension
2206.32 Sq mi
Scale in Miles
PROPOSED NAVAJO DISTRICT
EXTENSIONS
NAVAJO DISTRICT
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
REFERENCE Commercial Map
COMPILED Slattery
TRACED Williams
CHECKED D B M
DATE 6-30-36
N-403

Plate No. 2

justify the enlargement of the Navajo District are as follows:

1. The success of the land management program on the Navajo Reservation is dependent on the proper control of the upper reaches of the San Juan and Little Colorado Rivers.

2. The upper watershed of these two Rivers contributes large quantities of silt to the Colorado River and to the Boulder Reservoir.

3. The owners and operators within this outside area are vitally concerned with the problem of soil and water conservation and operations within their area would tend to decrease criticism of a concentration of work on Indian land.

The enlarged district has the approval of the Advisory Committees of the four states, Arizona, New Mexico, Utah and Colorado, portions of which are included within the district as indicated on Plate 2.

B

The importance of range control in the land management program on the Reservation is self-evident. One of the first steps taken by the Soil Conservation Service was that of conducting an ultra extensive range reconnaissance to determine the carrying capacity of the range. The results of this reconnaissance indicated heavy over stocking and the need for a general livestock reduction. The Soil Conservation Service has constantly maintained the necessity for such reduction and has given material assistance to the Indian Service in carrying out a program which, to date, has resulted in a general reduction of 207,502 sheep and goats. In establishing working areas over the Reservation, the Soil Conservation Service has insisted on the recognition of the need for range control and, in the majority of cases, has secured total exclusion of livestock for a period of at least one year, followed by restocking to the carrying capacity. Five demonstration areas are now restocked and under proper range management.

In order to secure the needed livestock adjustment to the carrying capacity of the range and also distribution of stock, it became necessary to consider the division of the Reservation into

Briefly the requirements of the Bonsall District were as follows:

1. The average of the land management provides on the Bonsall Conservation is dependent on the proper management of the upper watershed of the Upper Fallbrook and Lake Elsinore.

2. The upper watershed of these two streams contains large quantities of silt in the gullies which flows out in the Bonsall District.

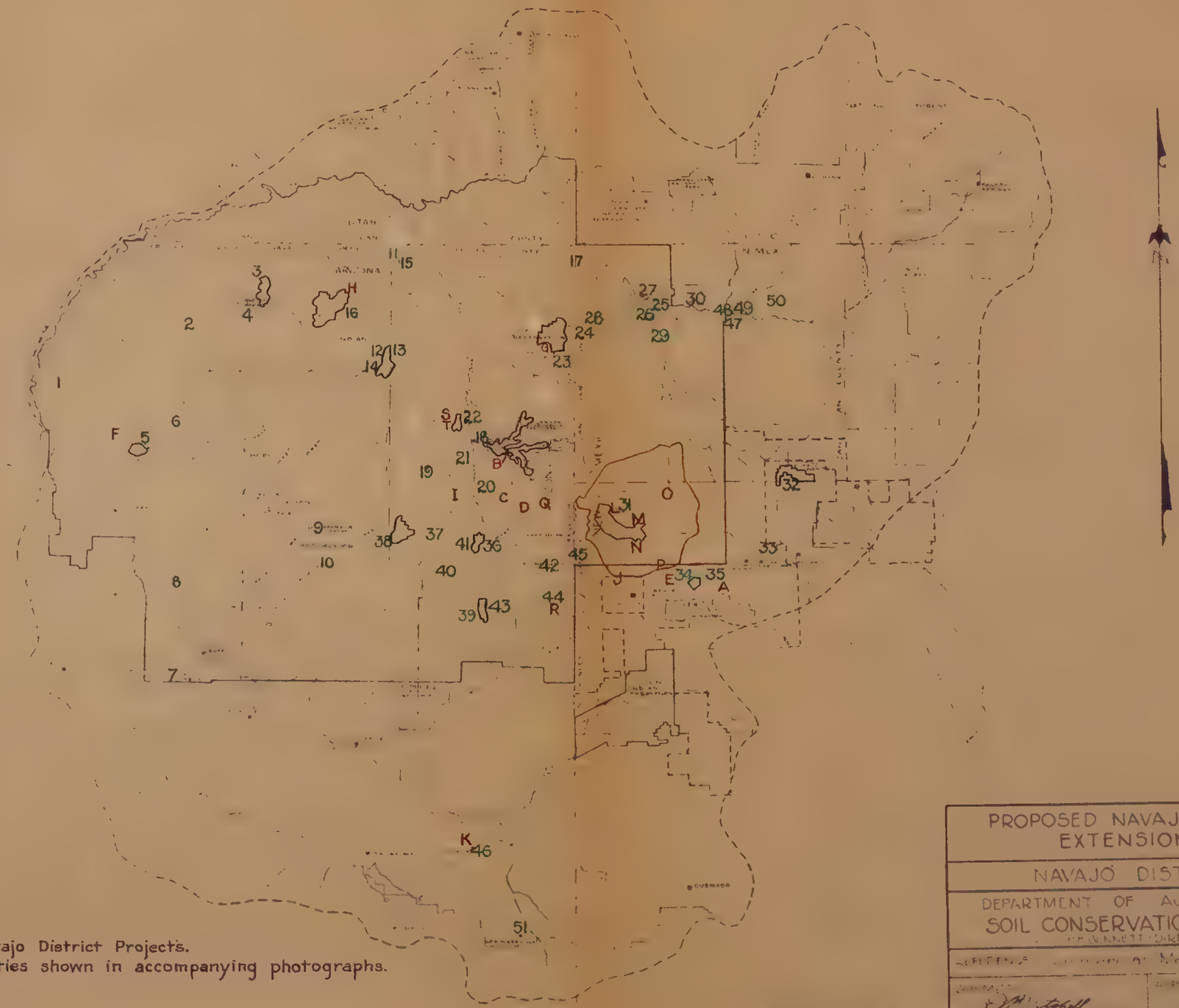
3. The owners and operators within this valuable area are vitally interested with the problem of soil and water conservation and operations within the district area would lead to discourage criticism of a conservation of work on Indian land.

The national directors has the approval of the Advisory committee of the four states, Arizona, California, Utah and Colorado, problems of which are included within the District as indicated on Plate 2.

2

The importance of range control in the land management program on the Conservation is well-evident. One of the first steps taken by the Soil Conservation Service was that of providing to allow adequate range conditions to determine the carrying capacity of the range. The provide of both vegetation values of heavy over stocking and the need for a general livestock reduction. The Soil Conservation Service has successfully instituted the necessity for such reduction and has given adequate assistance to the Indian Service in carrying out a program which, in fact, has resulted in a general reduction of 20% stock and range. In so activities regulation range over the Conservation, the Soil Conservation Service has assisted in the development of the need for range control and, in the majority of cases, has received total assistance of livestock for a period of at least one year, followed by reduction in the stocking capacity. This demonstration areas are now provided and under proper range management.

In order to assure the needed livestock reduction in the carrying capacity of the range and also distribution of stock, it became necessary to consider the interests of the Conservation Indian



Numerals indicate Navajo District Projects.
Letters indicate Localities shown in accompanying photographs.

PROPOSED NAVAJO DISTRICT EXTENSIONS

NAVAJO DISTRICT

DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DRAWN: E. W. Stokell
COMPILED: Williams
NUMBER: DBM
DATE: 6-30-36
N-403

Plate No. 4

a number of land management units on which it would be possible to enforce proper range control and other phases involved in land management. On November 6, 1935, the Secretary of the Interior issued regulations affecting the carrying capacity and management of the Navajo range, which permitted the establishment of such units. These units have been tentatively selected and are indicated on Plate 1.

Priority in making land management studies on these land management units is determined by signed agreements on the part of the inhabitants, or their representatives, whereby they agree to follow the plan of proper land use for their unit. Chapters within units eight, eleven, fourteen, and seventeen have signed agreements to this effect and studies have started. Because of objections on the Reservation to the use of the term "livestock reduction", it has been decided to use in the future the term "livestock adjustment".

Two areas outside the Reservation, one in the vicinity of Concho, Arizona, and the other near Farmington, New Mexico, were approved and the owners and operators within each have agreed to a range control program including stock reduction, as outlined by the range management branch of the Soil Conservation Service. Note Plate 4 for location of these areas.

C

The Navajo Indian Reservation is under complete administration of the Bureau of Indian Affairs. It was, therefore, only necessary to secure an agreement between the Bureau of Indian Affairs and the Soil Conservation Service to initiate a program of soil and water conservation. Cooperative arrangements between these two Services are indicated (1) in the general working plan of the Navajo Project; (2) in the informal agreement between the Secretary of Agriculture and the Secretary of the Interior dated June 5, 1935; and finally in the clarifying statement termed "Unified Navajo Program" approved in April 1936.

In addition to the general agreement with the Indian Service it has been the policy of the Soil Conservation Service to form cooperative agreements with the Chapters or Indians concerned in each administration or special working area. Such agreements usually cover approval of the range control program by the inhabitants and also the amount of contribution both by the Indians and the Soil Conservation Service.

In connection with the approved projects outside the Reserva-

tion, a number of Soil Conservation Associations have been organized. The Concho Soil Conservation Association embraces approximately 3500 acres located at Concho, Arizona, and includes twenty-seven members. In the vicinity of Farmington, Aztec, and Bloomfield, New Mexico, the following eight Associations have been organized:

Farmington Association,	40,300 acres
Aztec Association,	94,000 acres
Blanco Association,	35,400 acres
Cedar Hill Association,	80,640 acres
Bloomfield Association,	42,800 acres
Kirtland Association,	36,400 acres
Flora Vista Association,	12,160 acres
La Plata Association,	65,900 acres

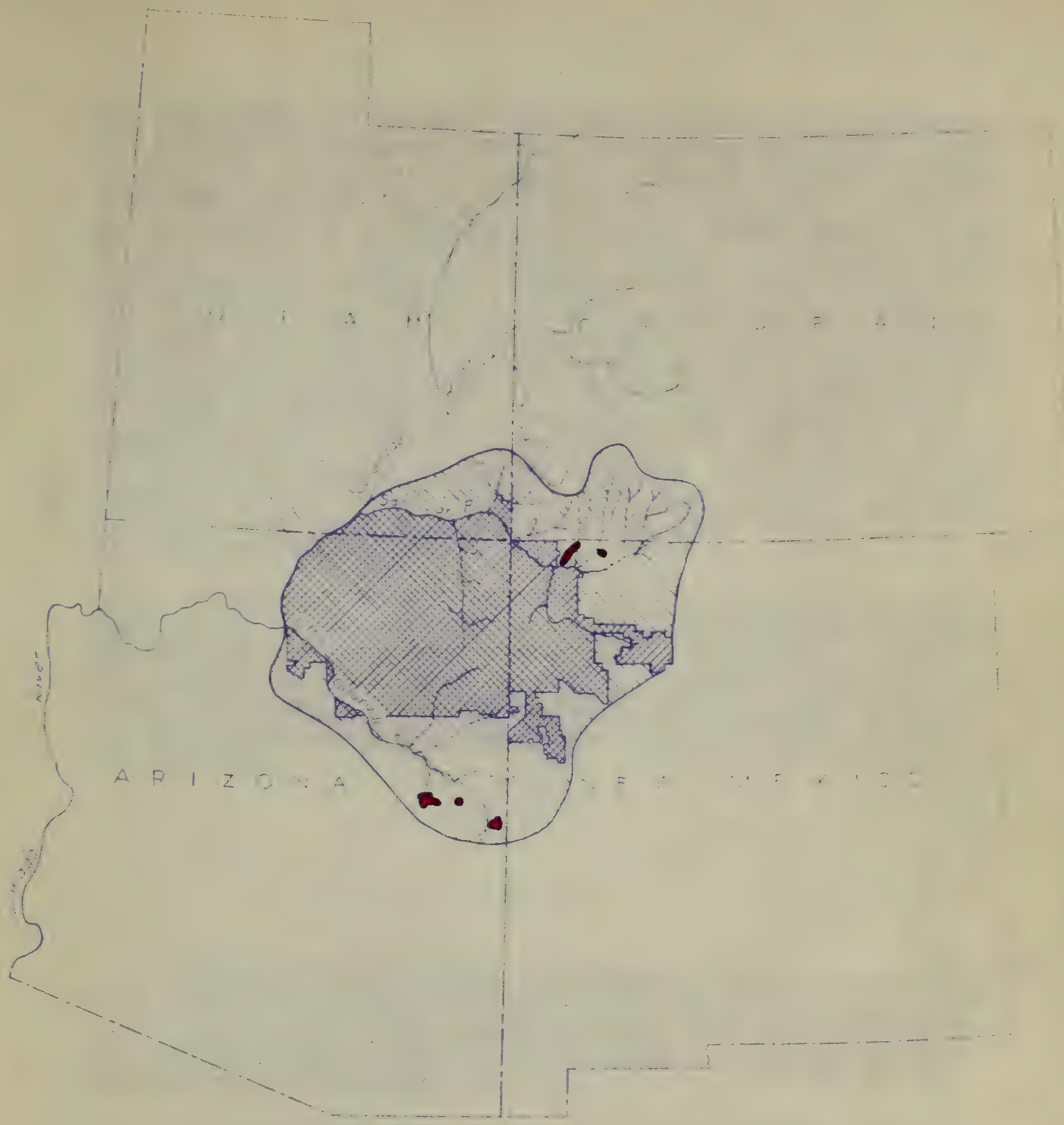
These Associations, all in San Juan County, New Mexico, cover a total area of approximately 408,000 acres and include 150 members. In addition to the community associations, a San Juan County Soil Conservation Association was formed embracing the entire County. The governing body of the County Association consists of one representative from each community association.

Excluding the informal cooperative agreements with the Indians the Navajo District has signed cooperative agreements covering the following projects or sub-projects: Concho, Arizona; Farmington Reservoir, North Farmington Ditch and Star Ditch, in the vicinity of Farmington, New Mexico; and the Knickerbocker Arroyo at Aztec, New Mexico.

D

The working plan for the Navajo Project outlines in general the approach to the problem of soil and water conservation on the Navajo Indian Reservation; indicating first the need for the collection of basic information covering all phases of the land management program; second, the demonstration of soil and water conservation through proper land use in order to pave the way for the acceptance of final plans; third, preparation of land management plans based on the information collected and, fourth, the application of final plans.

Any plan for the Reservation must not only consider the problem of soil and water conservation, but must also take into account the fact that the Navajo tribe is dependent for its livelihood on



LEGEND

Present Navajo Project

Proposed Extension

[redacted] SPECIAL AREAS ON WHICH GRAZING SURVEYS AND EROSION SURVEYS HAVE BEEN MADE.

RM. FIG - 3.

PROPOSED EXTENSION
NAVAJO PROJECT
NAVAJO DISTRICT

DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H.H. BENNETT DIRECTOR

REFERENCE Washington D.C. 3 May 1935

SUBMITTED APPROVED

COMPILED	TRACED	CHECKED	DATE
	W.A.R. Jr.		5 3 35

L-287

Plate 3

the productivity of the land within the limits of the Reservation. The problem is, therefore, one of rehabilitating the people as well as the land. Recently a more detailed method of approach has been developed applicable to selected land management units. A study group, composed of specialists in each phase of land management, is assigned to one of the land management units. The purpose of this study group is to obtain all available information from which it will be possible to work out a correlated land management plan for the unit. From the general discussion within this group, prior to undertaking the studies, each branch outlines its work and the procedure to be followed in order that there will be no duplication. Following the collection of all available data, a general discussion is held and a small committee appointed to work out the details of the land management program for the unit. This program will include not only an outline of the work required, but will also indicate various agencies responsible for the actual carrying out of the work according to plan.

A supervisor is appointed for each unit and it is expected that this supervisor will keep in close contact with both the study and planning groups in order that he may be better able to apply the plans and to see that the proper coordination is achieved. As stated previously, studies and plans have been completed on unit number fourteen and studies are underway on units eight, eleven, and seventeen.

E

Surveys of various types were initiated early in the development of the erosion control program for the Navajo Reservation and during the past year such surveys have been extended to special areas outside of the Reservation, as indicated on Plate 3. The accomplishments to date are as follows:

1. Aerial Surveys. 16,500,000 acres have been covered by an aerial survey. Contact prints to the scale of approximately two inches per mile and mosaics to the scale of two inches per mile, also one inch per mile, have been made available. Using index sheets and other available information, a tentative base map was prepared by the district staff for the Navajo Reservation to the scale of one-fourth inch per mile. This map is a very great improvement over any previous map of the Navajo Reservation, and is being used as a base for all planning and general land management work.

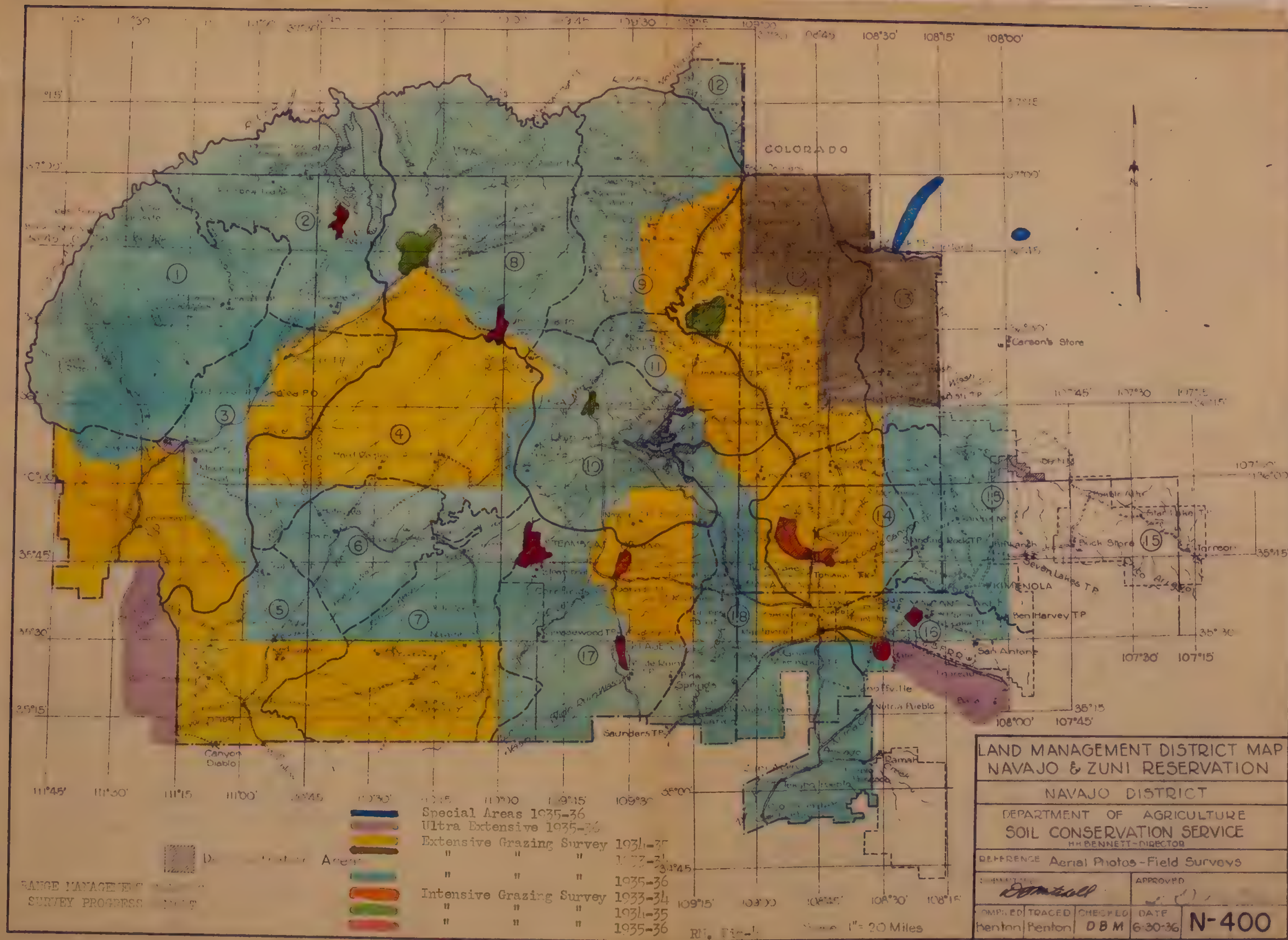
the productivity of the land within the limits of the Tennessee Valley region is, therefore, one of revitalizing the people as well as the land. Recently a more detailed method of approach has been developed applicable to activated land management units. A study group, composed of specialists in each phase of land management, is assigned to one of the land management units. The purpose of this study group is to develop all available information on that unit with a view to preparing a land management plan for the unit. When the planning directives giving range, value to conservation, such demand maintaining its work, and the programs to be followed in order that there will be no duplication. Following the activation of this multiple view, a general discussion is held for a week's conference attended by such men as the district of the land management specialist concerned for the unit. This conference will be only in activity of the unit physical, but will also include economic considerations for the well-all management and of the work accomplished to date.

A supervisor is established for each unit and is responsible that this conference will keep in close contact with the study and planning groups in order that it may be better able to apply the plans and to see that the proper coordination is achieved. As method procedure, assuming that plans have been completed on each unit, under direction and whether the subsequent to units right, slopes, and terraces.

X

Energy of various kinds have initiated work in the development of the western section for the Tennessee Valley and during the past year and several have been extended to central and eastern parts of the Tennessee, as indicated on Plate 3. The energy-conservation to date are as follows:

1. Burial Grounds. 30,000,000 acres have been covered by the burial survey. Certain plots in the state of Tennessee for burial purposes in the region in the state of the Tennessee per site, also the land per site, have been made available. Taking Lake Shelby and other available information, a beginning has been made for the directed plant for the Shelby Reservoir in the state of Tennessee land per site. This has a very good investment over any previous use of the Shelby Reservoir, and is being used as a base for all planning and general land management work.


LAND MANAGEMENT DISTRICT MAP
NAVAJO & ZUNI RESERVATION
NAVAJO DISTRICT
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H H BENNETT - DIRECTOR
REFERENCE Aerial Photos - Field Surveys
APPROVED
COMPILED Benton
TRACED Benton
CHECKED D B M
DATE 6-30-36
N-400
Special Areas 1935-36
Ultra Extensive 1935-36
Extensive Grazing Survey 1934-35
" " " 1935-36
Intensive Grazing Survey 1933-34
" " " 1934-35
" " " 1935-36
Scale 1" = 20 Miles
COLORADO
Carson's Store
Buck Store
Tarrean
Seven Lakes T.P.
Ben Harvey T.P.
San Antonio
Nutria Pueblo
Ramah
Saunders T.P.
Canyon Diablo
Pine Springs
Tohatchi
Standing Rock T.P.
Black Mtn
Star Lake T.P.
108°30'
108°15'
108°00'
107°45'
107°30'
107°15'
111°45'
111°30'
111°15'
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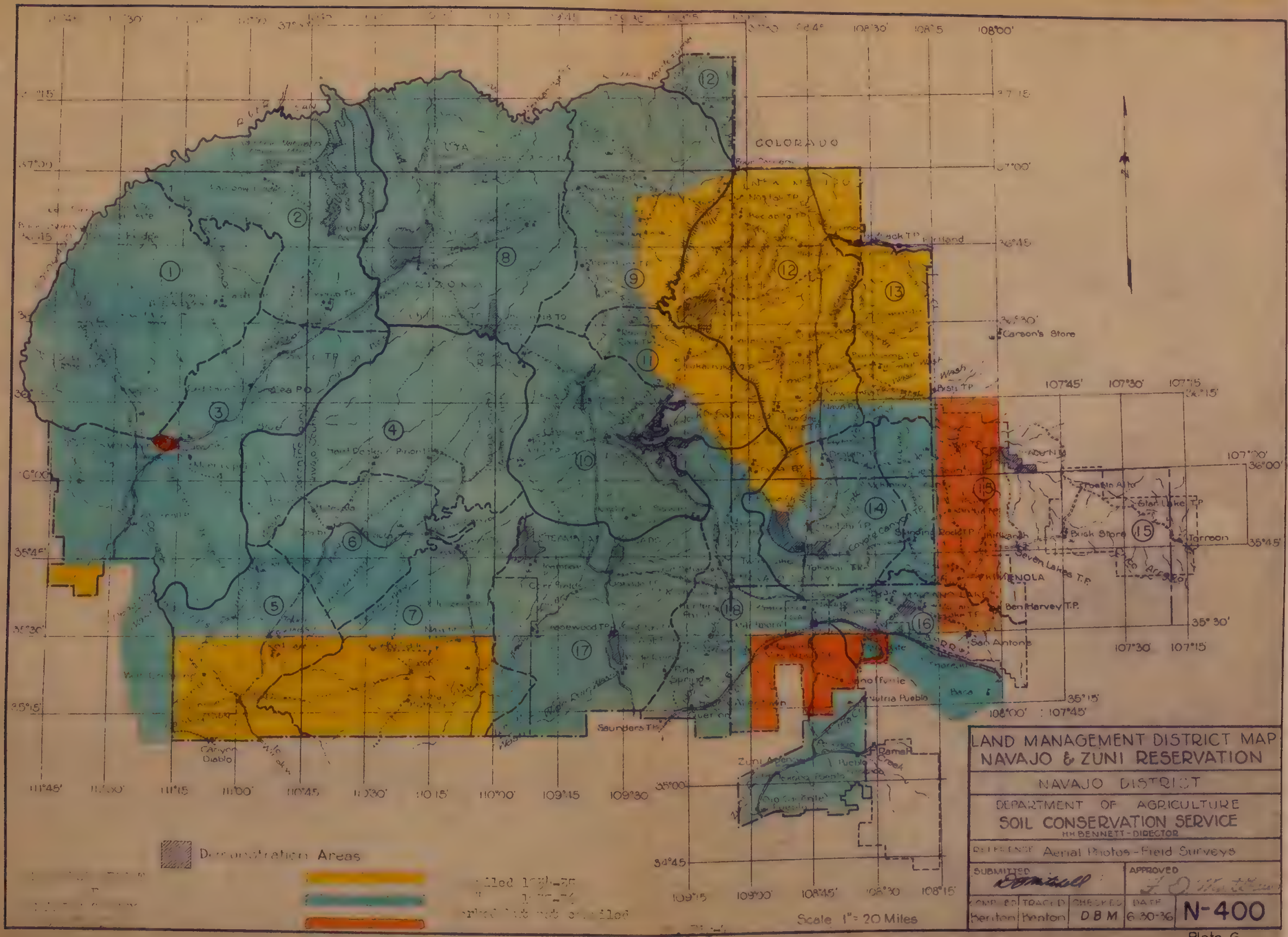
108°45'
108°30'
108°15'
36°45'
36°30'
36°15'
35°45'
35°30'
35°15'
35°00'
34°45'

Plate 5



LAND MANAGEMENT DISTRICT MAP
NAVAJO & ZUNI RESERVATION

NAVAJO DISTRICT

DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H H BENNETT - DIRECTOR

REFERENCE Aerial Photos - Field Surveys

SUBMITTED	APPROVED

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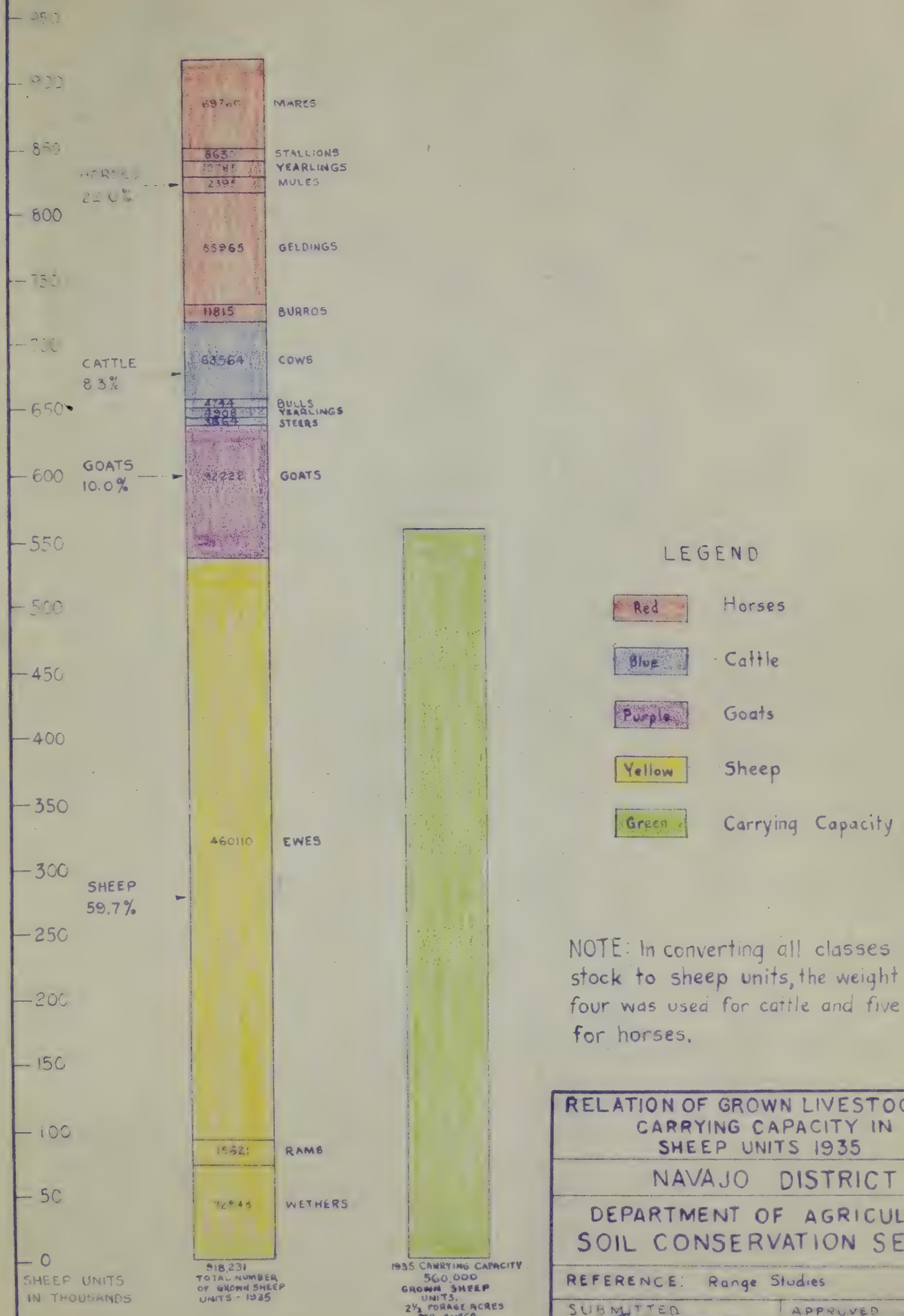
Plate 6



RELATION OF GROWN LIVESTOCK TO CARRYING CAPACITY IN SHEEP UNITS 1935

NAVAJO DISTRICT

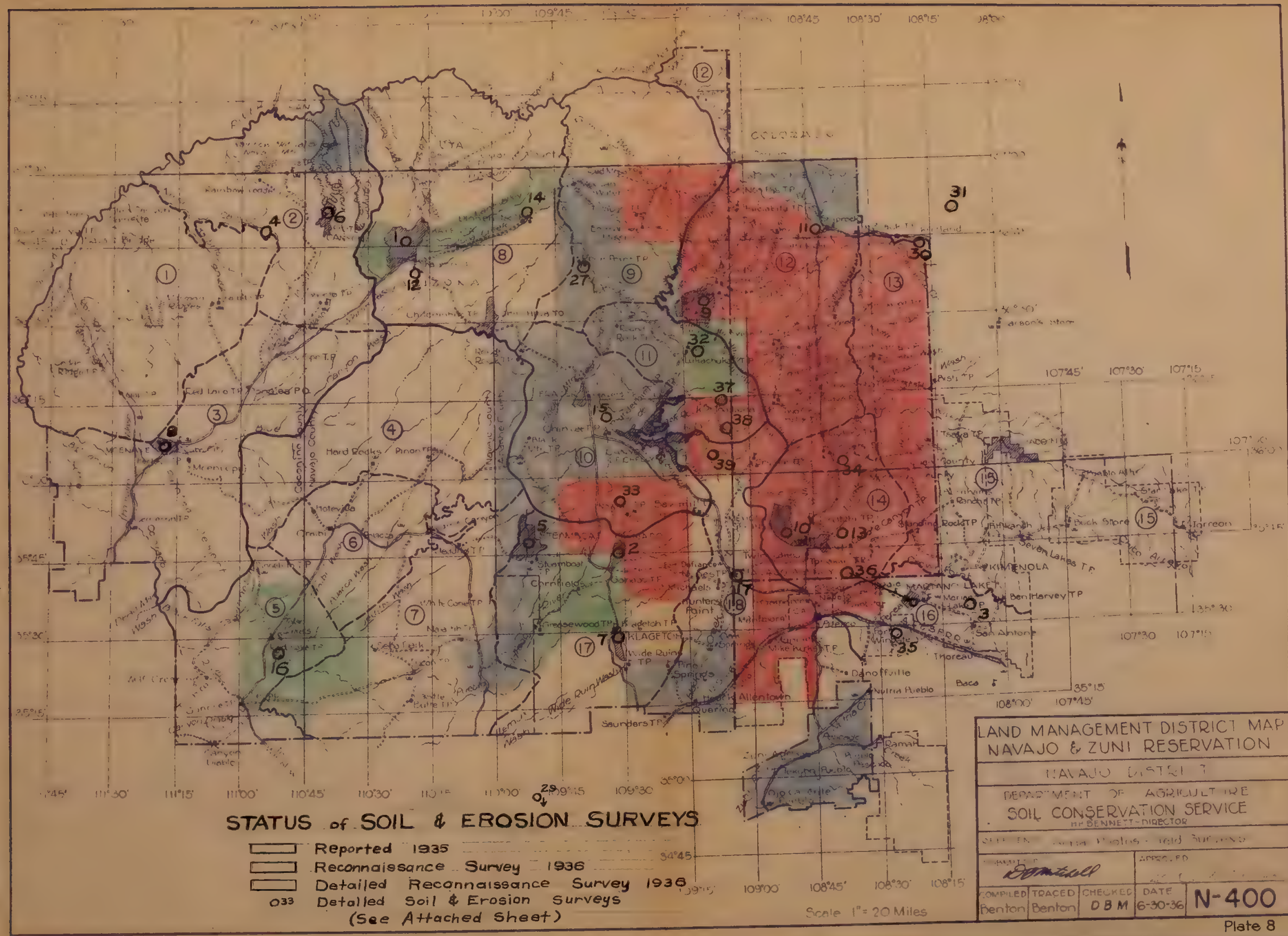
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

REFERENCE: Range Studies

SUBMITTED			APPROVED	
COMPILED C. MADDOX	TRACED BERMAN	CHECKED C. MADDOX	DATE JUNE 1936	L-401

RM. Fig-2

Plate 7



STATUS of SOIL & EROSION SURVEYS

☐	Reported 1935
☐	Reconnaissance Survey 1936
☐	Detailed Reconnaissance Survey 1936
○33	Detailed Soil & Erosion Surveys

(See Attached Sheet)

LAND MANAGEMENT DISTRICT MAP
NAVAJO & ZUNI RESERVATION

NAVAJO DISTRICT

DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H H BENNETT – DIRECTOR

[illegible] Aerial Photos - Field Surveys

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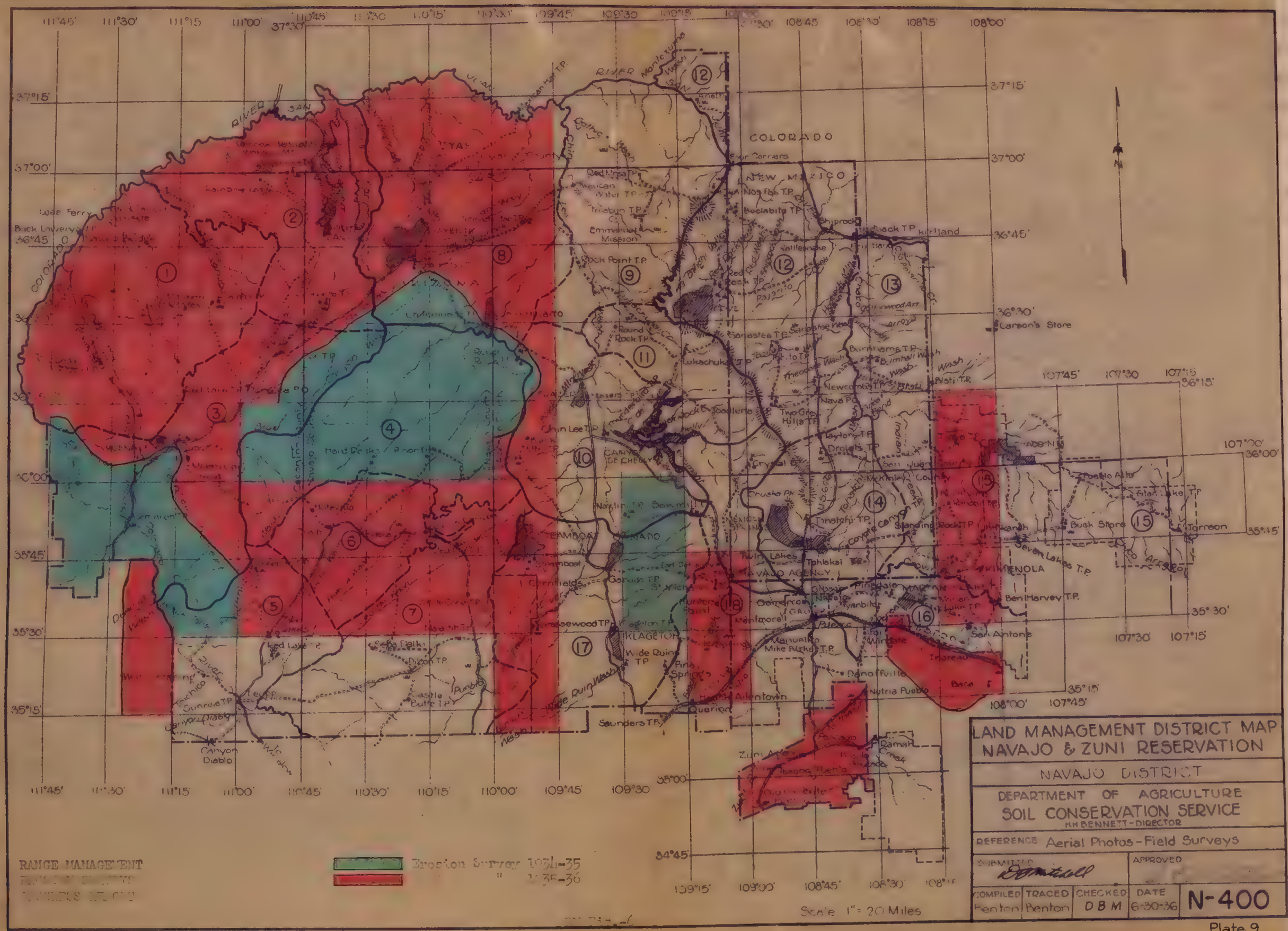
Plate 8



LAND MANAGEMENT DISTRICT MAP NAVAJO & ZUNI RESERVATION

NAVAJO DISTRICT

DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
H H BENNETT - DIRECTOR

REFERENCE Aerial Photos - Field Surveys

SUBMITTED	APPROVED
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COMPILED	TRACED	CHECKED	DATE	
Benton	Benton	D B M	6-30-36	N-400

Plate 9

RANGE MANAGEMENT
EROSION SURVEYS
[illegible]

🟩	Erosion Survey 1934-35
🟥	" 1935-36

2. Range Surveys. 16,707,130 acres have been covered by extensive surveys to date. During the past year, extensive range surveys were completed on 11,476,430 acres and compilation has been brought up to date for the entire area covered. Within the area covered by the aerial survey types were located and delineated on the one inch mosaics. Plane table maps were prepared for 85,945 acres, mostly within the Snowflake and Coyote Canyon area where aerial photographs were not available.

Where more detailed information was necessary, intensive grazing surveys were made. This includes all of the demonstration areas, Fort Wingate Experimental range, and the smaller special areas outside of the Reservation. Altogether, 210,209 acres have been covered by intensive surveys to date, 63,532 acres of which were completed during the past year.

The progress of range surveys is shown on Plates 5 and 6. The carrying capacity by land management units, as determined from the extensive range surveys, is indicated in Table I. The relation between the Reservation carrying capacity in sheep units and the estimated number of grown livestock in 1935 is shown on Plate 7.

3. Soil and Erosion Surveys. The Soils branch has completed reconnaissance soil and erosion surveys of 6,510,105 acres, including 1,020,105 acres completed during the past year. In addition to this, the branch of Range Management, in connection with their range surveys, made preliminary reconnaissance erosion surveys on 7,592,000 acres. Detailed soils surveys have been completed on 150,420 acres, of which 82,530 acres were completed this fiscal year.

The accomplishments in soil and erosion surveys are shown on Plates 8 and 9. The inked figures on Plate 8 refer to the following areas:

Areas Within Reservation

1	Moonlight Wash	14	Dennehotso
2	Canado	15	Chinlee
3	Mormon Flat	16	Tolani Lakes
4	Navajo Canyon	17	Navajo Agency
5	Steamboat	27	Rock Point
6	Piute Canyon	30	Fruitland
7	Klag-E-Teh	32	Dulaciahai
8	Moenave	33	Ganado

Areas Within Reservation (Continued)

9 Cove
10 Mexican Springs
11 Shiprock
12 Kayenta
13 Chuska
34 Naschitti
36 Mariano Lake
37 Tsailee
38 Wheatfields
39 Whiskey Creek

Areas Outside Reservation

29 Concho
31 Farmington
35 Wingate
Gunlock, Utah
Grantsville, Utah

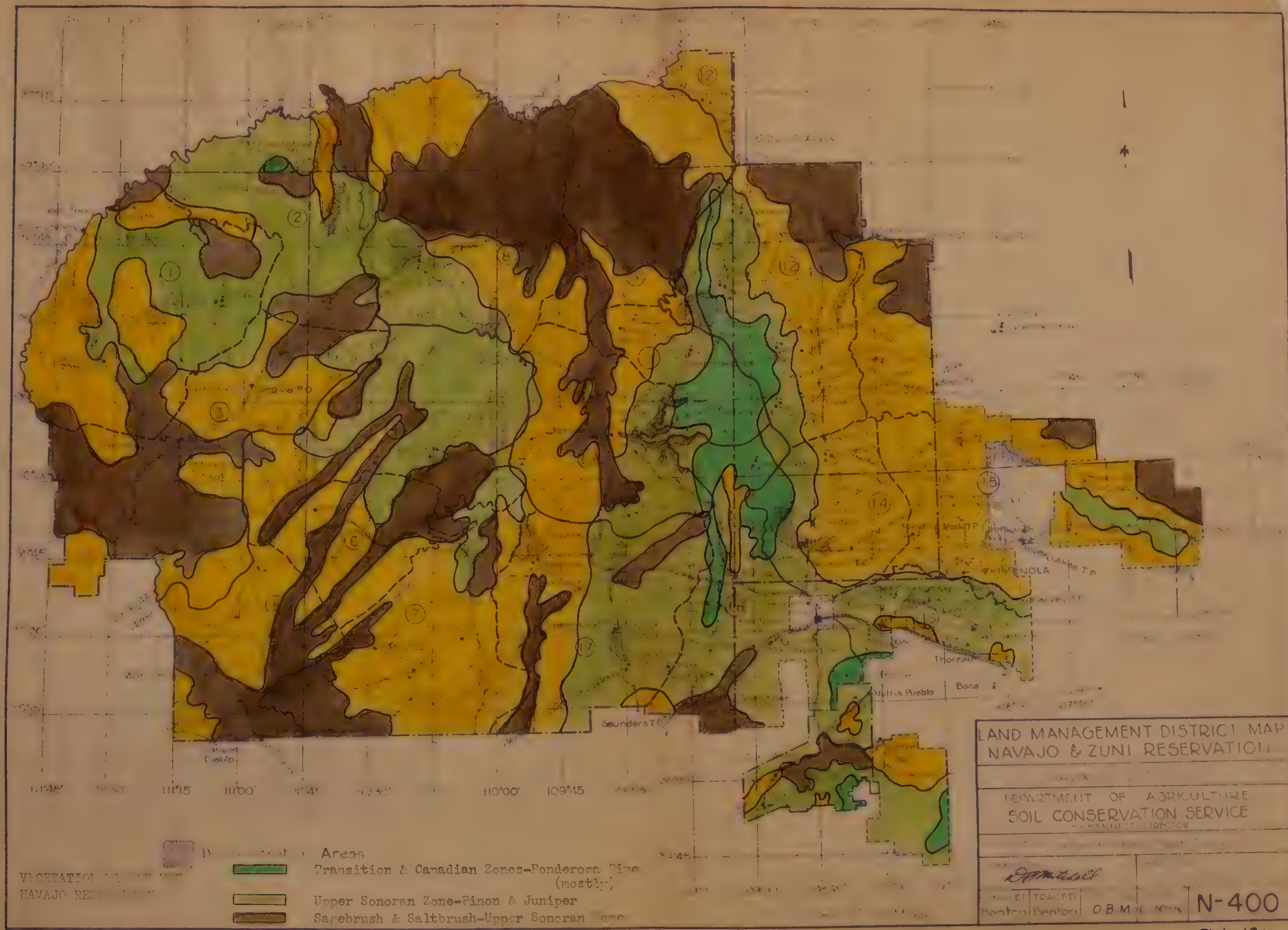
4. Agricultural Surveys. 15,020,400 acres have been covered by an agricultural survey to determine the amount of land being farmed at the present time and the amount of potential agricultural land which might be developed by the Indians with little or no assistance. The results of this survey showed that there are 42,232 acres of land in cultivation, classified as follows:

26,845 acres in Class A
15,156 acres in Class B
231 acres in Class C

Class A farms include all the better tracts on the Reservation with a soil of medium texture, level to gently sloping land free from alkali, with sufficient water available for crop production. The Class B farms include those where the texture of soil is more extreme, with a greater degree of slope, with possibly a small amount of alkali present - or where there is some doubt as to the availability of a sufficient supply of water for crop production. Class C farms are those which should be taken out of production because of excess slope, alkali, or lack of water.

The survey showed that there are 10,875 acres of potential agricultural land classified as follows:

5,249 acres of Class A
2,595 acres of Class B
3,031 acres of Class C


LAND MANAGEMENT DISTRICT MAP
NAVAJO & ZUNI RESERVATION
DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Areas
Transition & Canadian Zones-Ponderosa Pine (mostly)
Upper Sonoran Zone-Pinon & Juniper
Sagebrush & Saltbrush-Upper Sonoran Zone
Grassland
Thoreau
Nutria Pueblo
Baca
Saunders T.P.
Cuba
110°00'
109°45
N-400
Plate 10

Class C land includes areas unsuitable for crop production but where surplus water can be successfully spread for the production of native hay.

5. Water Spreading Survey. In order to determine the total acreage of Reservation land subject to water spreading, a survey was made by a group consisting of representatives from Agronomy, Engineering, Range Management, and Soils. Using aerial mosaics as a base, this group made a survey of 16,320,000 acres. This water spreading survey was predicated on the possible use of large spreading structures and on this basis shows that there are 23,970 acres of potential agricultural land and 6,815 acres of native hay land in addition to that shown by the agricultural survey. In addition to this, it was found that water could be spread over 160,300 acres of range land to increase forage production. Through the combined results of the agricultural survey and the water spreading survey, all of the present farms and all of the potential agricultural lands have been located on maps.

6. Forest and Woodland Survey. There has not been an extensive survey of the forest and woodland areas of the Reservation, but rather these surveys are being confined to the land management units. A general inventory of forest resources has been completed on approximately one million acres in this manner and surveys are being conducted in three land management units at the present time, which will bring the total area covered up to three million acres in the near future.

The forested areas within the Reservation are indicated on the vegetation map, Plate 10.

7. Biological Survey. A start was made on the biological surveys in the early part of the year, but owing to the necessity of assigning a biologist to land management studies it was necessary to carry on these surveys by units in a similar manner to the procedure being followed with forest and woodland surveys. The biological surveys include all forms of animal life and plant diseases.

8. Population Surveys. An attempt has been made to roughly estimate the population and distribution of population over the entire Reservation. Population by land management units is shown in Table I. Complete population studies are being made in connection with the land management units.

[illegible] of land [illegible] areas [illegible] for area production [illegible] [illegible] [illegible]

F

The general objective of the Soil Conservation Service on the Navajo Reservation is the restoration of the land to its maximum productivity in order that the Navajo nation, which is rapidly increasing, may obtain its livelihood within the present Reservation limits. The problem of human needs, therefore, assumes equal importance with that of soil and water conservation. Early reconnaissances indicated a large over stocking of the range as the cause of the rapid deterioration of the land, necessitating stock reduction, stock improvement through culling, proper stock management, additional water development, additional range land if possible, and the development of increased forage by water spreading or other means. To off-set any possible losses in income through the above program, due consideration had to be given to the protection of all present agricultural development, as well as further development of potential agricultural land - either through storage irrigation, flood irrigation, or dry farming. Due consideration must also be given to the protection and future proper management of the forest and other resources of the Reservation. To date, the Soil Conservation Service has established eighteen major working areas and twenty-nine minor areas. The majority of the larger areas were selected primarily for the purpose of demonstration, considering population centers, complete watersheds, representative conditions and the willingness of the inhabitants to cooperate. Other areas, especially cooperative ones, were selected on the basis of individual needs, either for relief or for protection from threatened damage to range or agricultural land. During this fiscal year twelve areas have been completed, insofar as structural treatment is necessary and have been turned over to the Range and Agronomy branches for administration. Five areas are now restocked with sheep or cattle to the estimated carrying capacity of the range, and the results of proper range management are being demonstrated to the inhabitants.

Recognition of the need for knowledge of the human dependency on resources resulted in the formulation of general plans for comprehensive social and economic surveys and intensive studies of institutional situations central to the Navajo livelihood. On the basis of these plans, preliminary social and economic studies were conducted in the Steamboat Canyon and Canyon de Chelly areas. These were followed by surveys in the Dennehotso and Toland Lake areas. In connection with the land management studies, surveys were conducted to determine the extent and distribution of the human and animal population and the use of agricultural, range and timber resources. In addition, through surveys of traders' accounts, an attempt was made to discover the proportions of commercial income derived from various sources.

The land management program, as now conceived, has for its principal aim the conservative economic utilization of all resources on a perpetual basis. Steps have already been taken to increase crop production through the development of new agricultural land and the improvement of existing farm land. Livestock reduction is being offset, in so far as possible, by improvement in grade and methods of handling. Plans have been formulated for the utilization of timber resources on a sustained yield basis. Construction work has been completed for spreading devices to irrigate approximately one thousand acres of crop land and five thousand acres of range land. It is planned to rapidly increase the number and extent of spreading structures until the total area of 191,005 acres shown as being susceptible to water spreading has been developed.

Through proper range control, it is hoped that the carrying capacity of the range can be increased to a point where it will be adequate for the rapidly growing population.

C

The accomplishments for the fiscal year 1935-36 are summarized in Table II.

TABLE II (Continued)

STATISTICAL REPORT - 1935 AND 1936

	This Year	Last Year	To Date
No. acres completed by detailed Soils and Erosion Survey	82,530	67,690	150,120
No. acres completed by extensive Soils Survey	1,020,105	5,490,000	6,510,105
No. acres completed by Biological Survey	8,256,700		8,256,700
No. acres covered by Preliminary Range Survey	303,320		303,320
No. acres covered by Extensive Grazing Survey	11,476,430	5,310,700	16,787,130
No. acres covered by Intensive Grazing Survey	63,552	146,657	210,209
No. acres covered by Agricultural Survey	11,660,400	3,360,000	15,020,400
No. acres covered by Water Spreading Survey	16,820,000		16,820,000
No. acres under Control and Treatment Finished	1,289,526	173,445	1,462,971
No. acres on which Treatment is Finished	160,445	80,237	240,682
No. Temporary Dams - Gully Control	241,428	96,208	337,636
No. Permanent Dams - Gully Control	1,638	39,336	40,974
No. Permanent Water Conservation Dams	282		282
Square Yards of Bank Sloping	254,354	1,565	255,919
Lin. Ft. of Diversion Ditches	215,202	33,442	248,644
Lin. Ft. of Bank Protection Structures	107,487		107,487
Acres Drainage Area of Gullies Controlled	60,247	60,248	120,495

TABLE II (Continued)

STATISTICAL REPORT - 1935 AND 1936

	This Year	Last Year	To Date
Acres Controlled by Water Conservation	101,247		101,247
Acres Developed by Agricultural Construction	10,679		10,679
Cubic Yards of Fills in Earth Dams and Dikes	486,753		486,753
Lin. Ft. Water Spreading Dikes and Fence Spreaders	584,429	42,513	626,942
Acres Planting - Forestation		5,978	5,978
Acres Planting - Revegetation	10,643		10,643
Acres Planting - Gully Control	1,201	3,696	4,897
Acres Farm Planting	63		63
Sq. Yds Planting - Bank Protection	1,584,768	6,516,984	8,101,752
Man Days Nursery Work and Plant Collection	4,001	1,033	5,034
Plant Collection - Number of Plants	290,650	1,320,485	1,611,135
Seed Collection - Hardwood - Pounds	1,205	3,300	4,205
Seed Collection - Conifers - Bushels		1,010	1,010
Acres Range Fenced to Exclude Grazing Stock (Dem. Areas and IRCW Reservoirs)	228,455	?	228,455
Range Management - Number Demonstration Plots		16	16
Rods of Fences Constructed	60,281	64,729	125,010
Man-days Fire Control	27	?	27

FOREWORD

The Navajo Soil Conservation District embraces an area of some 17,000,000 acres in the Colorado River Drainage. It includes all of the Navajo, Hopi, and Zuni Indian Reservations in northeastern Arizona, southern Utah, and northwestern New Mexico. The District lies in the southern part of the Colorado Plateau Physiographic Province and is essentially a mesa and canyon region developed in generally low-dipping sedimentary rocks.

This high plateau is much broken up by stream dissection and by local volcanic extrusions and ranges in elevation from little more than 3,000 feet above sea level to elevations above 10,000 feet. Most of the plateau surface lies between elevations of 4,000 feet to 7,000 feet, the higher elevations occurring largely in a mountainous region along the Arizona-New Mexico state line.

In the eastern part of the Reservation, coarse and fine textured soils occur in large, nearly unbroken bodies, with the latter predominating. The former occupy a moderately undulating plateau extending northward from Cross Point. The finer soils occupy lower areas extending westerly to the mountains and are often at or near the flood plain level of the streams and subject to occasional inundation during flood periods. Considerable areas of residual clay soils are present in the northern part of this body.

In the higher Lukachukai region, the residual soils have developed under a higher rainfall and greater vegetative cover and possess some of the characteristics of humid area soils.

In the central and western portions of the Reservation, the climate is more arid. The residual soils derived from the sandstones are often of shallow depth, usually friable and permeable throughout their depth and are often subject to serious sheet erosion, resulting in a complete removal of soil and the exposure of extensive areas of barren sandstone. Soils derived in place from these shales have relatively little horizontal extent, being confined largely to the steeply sloping and eroded sides below the sandstone caprock of the mesas. As a whole these soils are thin, subject to sheet and gully erosion, and because of this and their topography, are of little economic importance.

The climate of the Navajo Reservation is characteristically continental with a wide diurnal and yearly range in temperature. Furthermore, there are marked climatic differences following the physiographic variations. The climate at 3,000 feet may be characterized as hot and dry, becoming cooler and moister with increases

in elevation up to 10,000 feet. The bulk of the Reservation includes a series of plateaus ranging in elevation from 4,500 feet to 7,000 feet with a temperate climate, a mean temperature around fifty degrees, and an average precipitation of ten to twelve inches. Precipitation during the past year for the principle climatic stations is shown in Table III.

Approximately ninety-five percent of the vegetation within the project would be classed as Upper Sonoran, while the remainder would be included in the Transition and Canadian Zones. The Upper Sonoran vegetation includes pinon-juniper, woodland, brush land, and grass. The Transition and Canadian Zone vegetation includes ponderosa pine, englemann spruce, and douglas fir.

The vegetation can be classed by types as follows: woodland 21%; brush land 30%; grass land 36%; coniferous forest 3%; and waste, barren, and cultivated areas 10%.

The nearest possible estimate on the number of sheep units grazing on the Navajo and Hopi Reservations in September 1935, is 918,231. The estimated carrying capacity of these Reservations as determined by extensive grazing surveys is 560,000 sheep units.

Less than one percent of the district area is suitable for farming, and a substantial portion of this one percent would not be considered as farm land according to the usual standards. Both the Navajo and the Hopi Indians utilize flood plains for farming. This type of farming is unstable and the production varies widely from year to year. In the Lukachukai mountains and the Fort Defiance plateau, with an annual precipitation up to twenty inches, crop production is much more dependable. These high-land farms with their deep rich soils are especially adapted to the growing of grains and root crops.

Small irrigation projects are distributed fairly well over the entire Reservation. The total area under irrigation is 25,604 acres, but only a small portion of this land has been completely subjugated. The most important projects are along the San Juan River, including the Hogback and the Fruitland-Kirtland Projects.

The Navajo forests occupy approximately 2½% of the total area of the Reservation. The dominant type on 21% of this area is pinon-juniper woodland. Approximately 3% is predominantly ponderosa pine including some areas of douglas fir, aspen, englemann spruce, white spruce and oak. Estimates of the volume of wood products in these stands run into billions of units measured in board feet, cords, posts, etc. Annual increment figures are also very large. These figures tend to give a false sense of plenty unless it is borne in mind that they represent the accumulated growth and

TABLE I

GENERAL INFORMATION ON LAND MANAGEMENT UNITS

Unit No.	Unit Name	Acreage	Estimated Population	Carrying Capacity Sheep Units	Acres Per Sheep Unit
1	Echo Cliffs	1,310,522	1,350	42,014	31
2	Navajo Mountain	960,271	1,100	16,853	57
3	Tuba	1,574,180	2,075	32,606	42
4	Black Mesa	1,102,670	2,139	31,709	35
5	Toloni Lake	659,157	1,106	24,546	27
6	Hopi	555,115	3,037	20,300	27
7	Castle Butte	1,131,600	2,535	57,151	20
8	Monument	1,103,606	1,600	29,310	40
9	Carrizo	1,010,163	2,175	19,338	52
10	Chin Lee	827,761	3,220	34,375	24
11	Tsailee	433,661	1,970	16,734	26
12	Shiprock	1,320,220	3,575	51,606	26
13	Cottonwood	400,114	2,730	17,339	23
14	Five Chapters	606,205	2,100	25,620	25
15	Crown Point	730,013	3,600	7,622	29
16	Ganado	462,675	2,050	Mostly outside - Not yet complete	
17	Pueblo	1,142,634	3,930	74,363	15
18	DeChanco	1,041,731	5,300	31,060	17
	TOTALS	16,516,778	46,752	575,766	29 Av.

TABLE III

PRECIPITATION TOTALS - NAVAJO DISTRICT

JULY 1935 TO JUNE 1936 INCLUSIVE

	1935 July	1935 Aug.	1935 Sep.	1935 Oct.	1935 Nov.	1935 Dec.	1936 Jan.	1936 Feb.	1936 Mar.	1936 Apr.	1936 May.	1936 June	TOTAL
#123 Chilchinbito D. A.	.98	1.01	.74	.25	.31	1.24	.03	.50	.26	.00	.18	.09	5.39
#124 Cove D. A.	1.41	1.64	1.27	.41	.78	1.10	.11	1.60	1.10	T	.30	.09	9.81
#125 Fraser D. A.	.75	1.19	3.04	.00	.18	.62	.21	.59	.70	.14	.32	.08	7.82
#126 Ganado D. A.	1.41	2.32	1.00	.00	.20	.17	.03	e	.25	.20	.02	1.00	6.60 e
#127 Keams Canyon	1.24	1.20	.76	T	.71	.40	e	e	e	e	e	e	4.31 e
#128 Mariano Lake D. A.	1.26	2.61	1.03	.31	1.38	.68	.69	1.47	.34	.20	.81	.24	11.82
#129 Nayenta D. A.	T	.94	.87	.30	.42	1.05	.10	1.17	.15	.00	.20	.24	5.44
#130 Moen Ave D. A.	.43 a	.41	.38	.00	.70	.40	.25	.30	.08	.00	e	e	3.23 e
#131 Piute Canyon D. A.	.64 a	1.22	1.58	.90	.65	e	.64	.22	.50	.02	.22	.33 d	6.92 e
#132 Mexican Hat, Utah	.06 b	.29	1.35	.15	.04	.58	.04	1.14	.18	T	.09	e	3.92 e

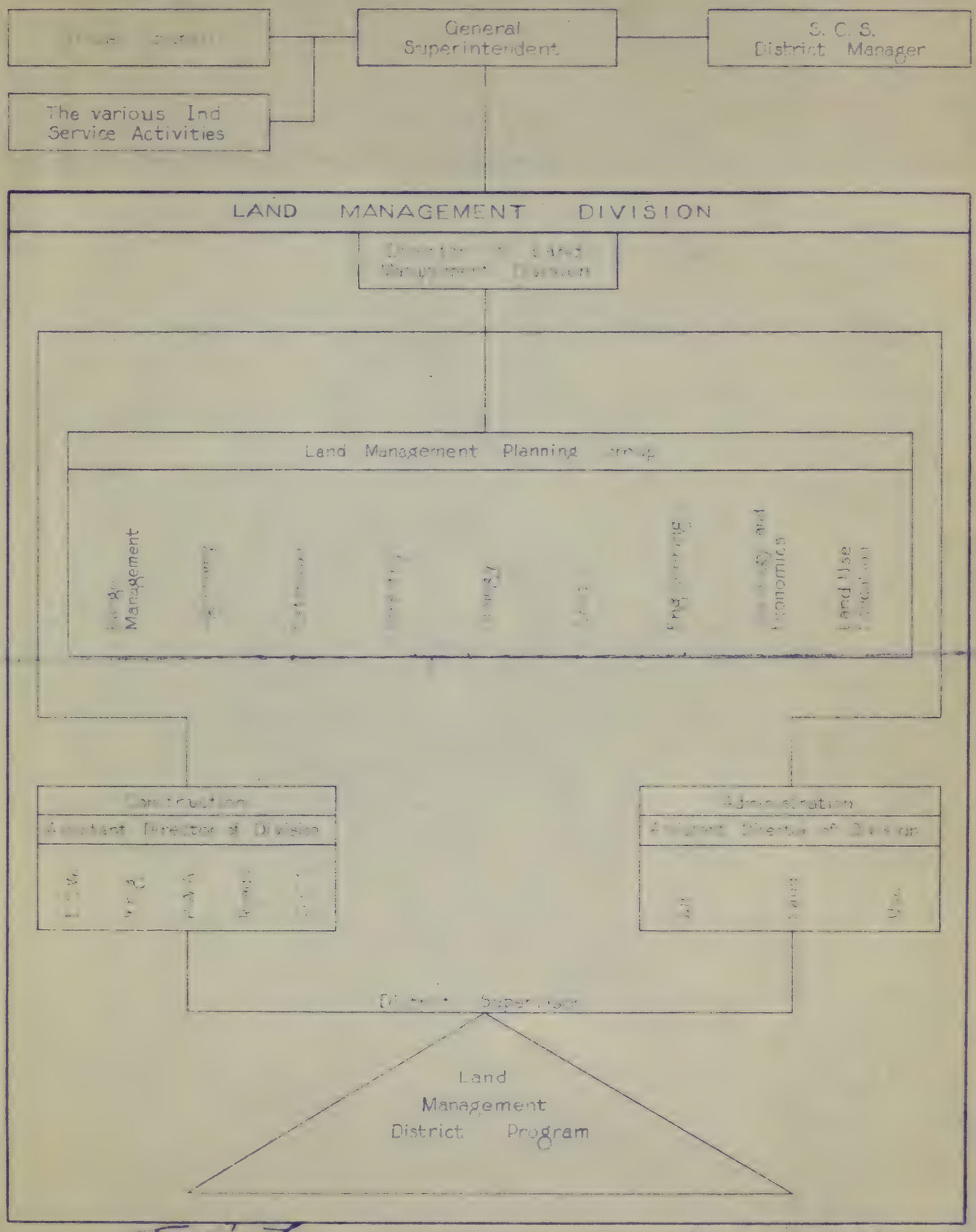
a. Established July 5, 1935.
b. Established July 17, 1935.
c. No report.
d. Station closed after June 25, 1936.
e. Not complete

development of the forests for centuries past. Any cutting of live trees at the present time is a direct loss of capital growing stock. This is true because of the fact that young trees are almost entirely absent on practically all parts of the Reservation. At the same time, present stands are largely over mature and to a great extent decadent.

Erosion conditions on the Navajo District are variable, but in general show considerable soil depletion. East of the Lukachukai mountains, sheet, gully, and wind erosion are everywhere active, and the area east of the Chaco River shows some of the most serious water erosion on the Reservation. Under the most severe conditions, soil is practically absent, vegetation is almost non-existent, and the magnitude of possible erosion control is beyond all practical considerations. In the southern part of the Reservation, the residual soils on the mesas are prevailingly thin and over considerable areas the sandstone is devoid of a soil cover. In the intervening valleys, the alluvial fill is deep and is being rapidly dissected by heavy runoff from the over grazed watershed.

Sheet, gully, and wind erosion are all severe in the southwestern portion of the Reservation, gully cutting being particularly severe, especially through the development of lateral gullies. These are developing in numerous localities and by continual head branching and growth are accelerating the loss of soil from extensive areas. The light soils, together with a low density of vegetation in the western part of the Reservation, make this area particularly susceptible to wind erosion. The northeastern portion of the Reservation shows considerable wind and water erosion. This region, as a whole, possesses far greater relief of canyons, cliffs, mesas, and spires than the remainder of the Reservation.

ORGANIZATION CHART
LAND MANAGEMENT DIVISION
NAVAJO RESERVATION



Approved E. L. Fryer

Approved Hugh Calkins

Approved

Approved

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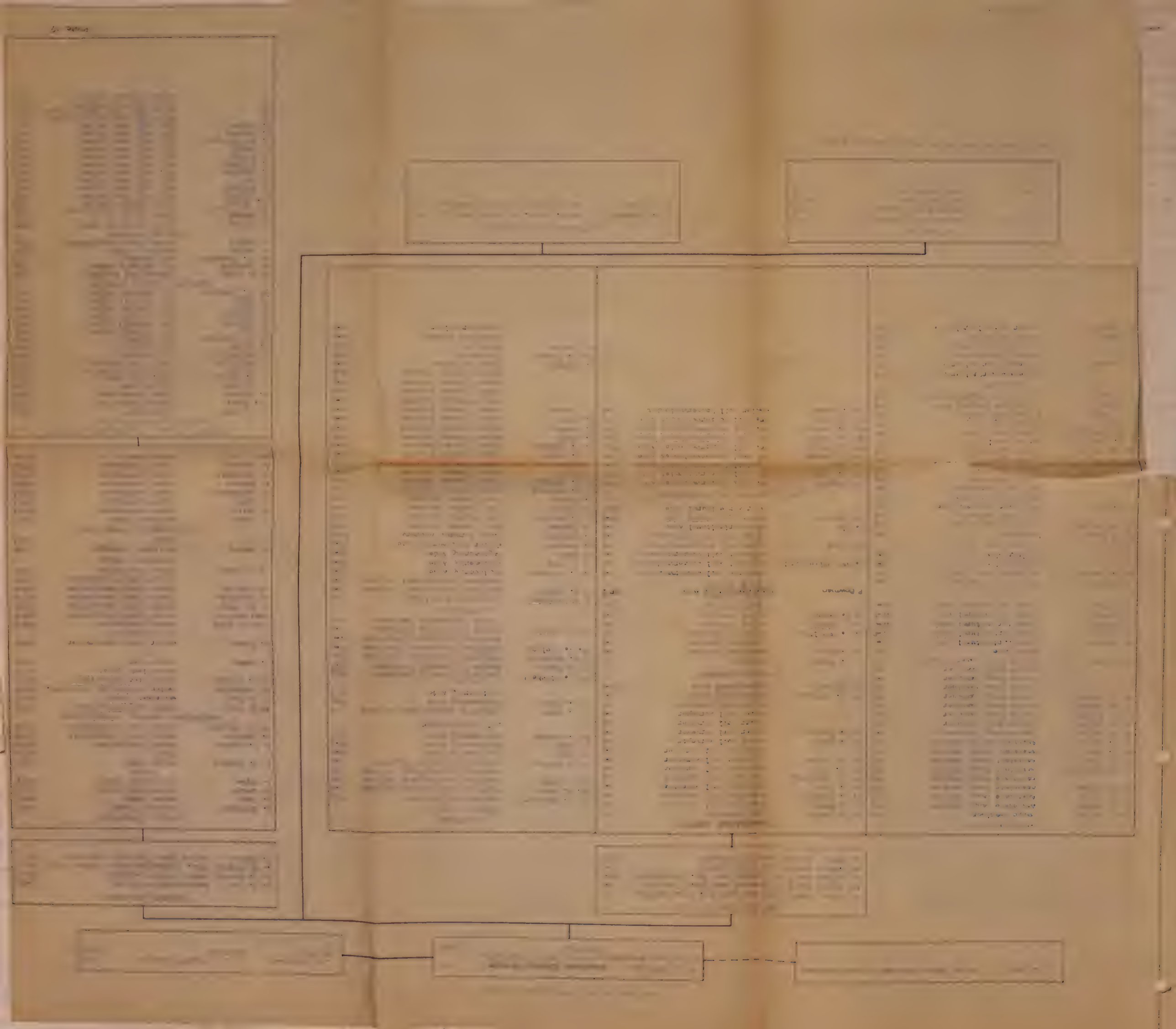
Plate 11



PROCEDURE

Organization:

At the beginning of the fiscal year headquarters for the Navajo District was at Albuquerque, New Mexico. At that time, the number of personnel on permanent appointment, including professional, subprofessional, clerical, and custodial services, was 116. Each branch chief reported directly to the District Manager.

With the establishment of Region number eight and location of headquarters at Albuquerque, it was decided to transfer Navajo District headquarters closer to the scene of operation. It was first intended to house the entire business staff and technical branch heads at the Navajo Agency and the other activities at Gallup. But, because of lack of space it was necessary, in February 1936, to move the business office into Gallup, leaving the Associate District Manager and the land management branch chiefs, with a small stenographic force, stationed at the Agency. All other activities are located in Gallup except for a small branch office, garage, and warehouse at Winslow, Arizona.

Many changes, both in personnel and organization, have taken place during the fiscal year. It has been necessary to release certain individuals to other districts and to the Region, replacing them with new men. The original cooperative working arrangement with the Indian Service was not sufficient as a closer integration of activities was required and this resulted in the "Unified Navajo Program". The work chart, Plate 11, indicates graphically the new arrangement with the establishment of one land management division to include personnel from both Services. The personnel chart, Plate 12, gives the names and positions of the Soil Conservation Service employees on the District as they fit into the Reservation land management division. This chart gives the status as of June 30, 1936 and, excluding the appointments pending on this date, includes a total of 167 on permanent appointment. Because of the difficulty in securing qualified personnel, there are still a number of open positions as may be noted. If W.P.A. funds are not available, it will be necessary to increase the number of custodial employees in order to replace those now paid from W.P.A. funds.

Office Management. As indicated on the personnel chart, the division of Office or Business Management is not included within the land management division. It may be noted that the branch garage, warehouse, and operation equipment is placed under Business Management. This was believed necessary in order that close supervision can be maintained over warehouse and property records, cost and prop-

Conclusion

As the beginning of the Fifth Year approaches for the Family Planning and Population Program, the picture is, in the main, one of growth in programs, knowledge, and experience. It is also one of continued or increased demand for services, including information, education, clinical, and counseling services, and the Program is being challenged to meet the demand.

Even the optimistic forecasts of Indian leaders about family planning in Kinnipurana, it was assumed by Kinnipurana officials, would be fulfilled. It was clear that the Program officials in Kinnipurana felt that the Program had contributed to the Kinnipurana Ministry and the other participating ministries, and, perhaps, lessons of hope of proof of its own usefulness. In Kinnipurana, the Ministry of Health, the Kinnipurana Medical Association, and the Kinnipurana Medical Institute and the Kinnipurana Women's Association, with a small administrative force, established an idea factory. All other activities were focused on making concepts for a social health action program, and mobilizing an idealism, dedicated.

Many challenges, both in personnel and organizations, have been taken during the Fifth Year. It has been recognized, in retrospect, that it was inadvisable to rather distant and to big jumps, proceeding faster than was safe. The medical organizations working directly with the Indian Ministries was not initiated as a direct consequence of participation in the medical and their associated in the Functional Health Program. The work should, rather, be, indicated (predictably) the way in-experienced, with the exception of the Joint Consultant Training in Indian personnel from both Ministries. The commended change, then, is, where the means and capabilities of the Fifth Consultation Training activities in the Ministry of Health, it from the Demonstration Joint experienced direction. This change gives the effective of the Joint Ministry, and, producing the organizations problem in this date. Indeed, a total of 107 ear personnel experiments. Because of the difficulty in medical personnel, there are still a number of open positions in many in medical. Of course, great has not evaluation, it will be necessary to increase the number of medical personnel in order to provide these new jobs over time.

Other Programs. As indicated in the previous study, the attitude of Indian or Indonesian Programmers in the individual within the Joint Programmers directions. It may be added that the Indian Ministry, and Ministry, activities in direct under Indonesian Ministry. Both the Indonesian Ministry, in order that their Ministry, in the individual their Ministry and primarily their, it, and and prog-

erty accounts, and transportation and garage, which is a major item in the Navajo District because of the large number of transportation units and the large volume of garage work necessary to keep these units in operation. The volume of transportation business is large because of the vast area within the Navajo District and the fact that the transportation of all materials, supplies, etc., as well as the personnel, is dependent entirely upon Government operated equipment as there are no railroads, bus lines, or other means of transportation on the Reservation.

The transfer of the ordinary activities of the business office from Albuquerque to Gallup was a slow process but at the close of the fiscal year, the Navajo District office had assumed full responsibility for all administrative and fiscal functions. The various activities included under the heading Business Management are Administration, Payrolls and Personnel, Fiscal, Procurement, Property and Cost, Files, Stenographic Pool, and Field Clerks.

The division of Business Management has assisted the Indian Service in establishing an employment service for the benefit of all work agencies on the Navajo Reservation. When this service is functioning properly, it will provide for the employment of those in greatest need of work. It is expected that all agencies engaged on the Reservation will requisition their laborers through this service.

A safety committee was appointed and reported a total of 107 accidents during the fiscal year. Of this number, which includes injuries to both permanent and temporary employees, only 53 were lost time or treatment cases. This committee handles a large volume of work, principally education, safety, and accident prevention work, as well as making periodical safety inspections.

Technical Staff. The land management program on the Navajo District involves the following activities: Range Management, Biology, Agronomy, Land Use Education, Conservation Surveys, Woodland Management, Economic Studies, and Engineering (Surveys and Plans, Drafting, and Construction). As indicated on the personnel chart, all the above branches are placed under the Land Management division and each branch chief is responsible to the Director of the Land Management division. The Land Management division is responsible for studies, plans, and application of all plans involving proper land management on the Navajo Reservation. Accomplishments by the Land Management division are shown elsewhere in this report.

The branch of Conservation Surveys on the Navajo District is responsible for the operation of a district soils laboratory. During the fiscal year this laboratory has made complete water and soil analyses for all districts within Region number eight. The

total number of samples submitted to the laboratory and analyzed was 2,614.

The Drafting section of the Navajo District has been seriously handicapped because of lack of personnel, but working in conjunction with the drafting office in Albuquerque, this section has completed 166 jobs for the various branches of the Navajo District. In addition it has assisted in the compilation from aerial mosaics of a base map for the Navajo Reservation. It has also reviewed a large number of halftone reproductions, locating on each quadrangle such information as names of streams, trading posts, highways, telephone lines, etc. With the purchase of a printing machine, this section is now able to make its own prints.

Work Agencies. Beginning August 16, 1935, W.P.A. funds were made available for the employment of temporary laborers for the Navajo District. This resulted in a complete change in the employment and personnel procedure and in alteration of fiscal accounting methods. During the period from August 16, 1935 to June 30, 1936 inclusive, 4,510 work assignments were made. The Navajo District served as its own assignment agency in the employment of all Indians. The number of temporary employees assigned has averaged 1,275 per month and reached the peak of approximately 2,500 during the months of November and December 1935. Approximately 957 man years of labor were provided through use of W.P.A. funds. No E.C.W. funds are available on the Navajo District.

METHODS

Control Measures Used - Application and Results:

Control measures used for the purpose of water and soil retention, water spreading and arroyo treatment consist mainly of engineering structures and have been confined in the past to demonstration or other work areas. Through cooperation with the inhabitants, these areas were placed under range control which is the first prerequisite to structural control.

Because of the demonstration aspect, there has been a tendency to intensify the work on certain of the areas, but on the land management units, this work should proceed on a control basis and according to well developed plans.

a. Structures used for the purpose of water and soil retention on range land within the Navajo District in-

clude contour furrows, impervious contour dikes, and wire, rock, or brush spreaders. The former structures are used on the flatter slopes in the upper watershed, whereas, the spreaders are used on the steeper slopes to retard the flow and cause an even spill. In all cases, impervious diversion dams were built where the structures cross the gullies. In the larger gullies, dams have been built to equalize the flow of water and to break its flood peak. On farming land, terraces have been used to advantage in retaining both soil and water. These terraces are usually of the bench or Mangum type.

This type of engineering treatment has proved to be very effective in the upper watershed regions, as the water is permitted to penetrate into the soil, rather than to run off the slopes carrying with it the productive top soil. It is work that can readily be undertaken by the Indians themselves at a small cost.

b. In many sections of the Navajo District, erosion has developed to the stage where deep arroyos are subdraining valuable range and farming land. Where suitable spreading areas are to be found, it has been possible to take the water from the arroyos and spread it on the land through means of a diversion dam with training dikes and spreaders. This type of treatment is confined to flatter slopes and to the upper watersheds unless the drainage area above the structure is under complete control. If the spreading area is of sufficient size, the entire flow may be diverted through use of an earth structure, but in many instances only a portion of the flow may be diverted and an over-flow type dam must be built. After diversion from the gullies, the water must be spread over as large an area as possible in order to delay its return to the channel and hasten revegetation of the land through irrigation. The spreader structures are built either on the contour or a slight grade, depending on the type and amount of runoff. The impervious dike is used to carry the water away from the banks where it may be spread by means of low rock or brush dikes, low woven wire fences backed with brush, or low sack dikes with small openings for seepage. Water spreading permits a quick return of the vegetative cover by placing on the land an amount of water equal to two or three times the annual precipitation. It may be used to increase the forage on range

land or to provide water for flood irrigation on farming land. As indicated in the general survey of the Reservation, water spreading will increase the present acreage of farming land by 30,705 acres and will also result in an increase forage over an area of 160,300 acres.

c. One of the main problems on the Navajo District requiring structural treatment is that of controlling active head and lateral erosion. It is hopeless to expect vegetation, even under perfect range management, to keep pace with this erosion until it has had a chance to attain its growth, thus some means of artificial control is required. The type of treatment depends on many factors, such as drainage areas, soil, vegetation, and topography, but in general may be divided into three classes - diversion, centrally built drop structures, or sloping of banks.

The best method in use on the Reservation, where it is feasible, has been the diversion of runoff by means of an impervious dike, located just above the point of active erosion and the spreading of the water before it returns to the arroyo. By diverting the flow, the arroyo has a chance to heal and revegetate; and through spreading, revegetation is hastened. This method, however, is confined to those areas where the runoff is not excessive and the valley broad enough for spreading.

Where the topography does not permit spreading or the runoff is too great, the water is dropped into the arroyo through one central structure, thus alleviating further head erosion. Depending on the permanency required, these structures are built of concrete, masonry, sacks filled with cement and sand, of wire and rock, or timber and brush.

Artificial sloping of the banks at the head of an arroyo has not proved entirely satisfactory in the Navajo country, because of the low rate and the poor seasonal distribution of precipitation. If the water is diverted from the arroyo, the banks take the angle of repose through natural means.

The main arroyo has been treated through structural means only where necessary to establish a base level of cuttings. Structures used in this case are either low or submerged check dams built of wire, rock or masonry. Lateral erosion has been largely controlled through the use of planting, but until they obtain their growth these plantings must be protected by artificial structures, such as jet-

tion, dikes, and fences.

It should be noted that one type of structural control may be used for several different purposes. For example, a diversion dam constructed mainly for the purpose of spreading water may also serve to control the arroyo and retain both soil and water. The term water conservation has been used throughout the Navajo District to cover all three classes of control measures. The actual type of structures used, as well as the purpose they serve, will be further discussed under the heading "brief description of work areas".

d. The first step in range improvement was to make an inventory of livestock and range resources. Range surveys for the entire Reservation were completed this year and the number of sheep, goats, and cattle determined from records obtained at the dipping vats. The number of horses was determined by a range count. These data have been compiled and form the basis of the present plans for the livestock adjustment program.

All together, the range improvement program has included the construction of 358 miles of fence. In cooperation with the Indian Service, and E.C.W., 3,277 acres have been fenced above reservoirs; 191,438 acres are included in the various demonstration areas, and 101,616 acres are included in special areas. All of these areas are properly stocked, under stocked, or have livestock exclusion. During the past year, the branch of range management approved 240 sites for the development of stock water. These included 40 drilled wells, 124 springs and shallow wells, and 76 reservoirs.

In addition to the Reservation-wide program of livestock control and range improvement, considerable attention has been given to the development of demonstration areas. These areas, under the complete control of the Soil Conservation Service, are being restocked to the proper carrying capacity of the range.

Five of these areas have been fenced and stocked, namely, Marimo Lake, Canado, Frazer, Klag-B-Toh, and Kayenta.

Marimo Lake Demonstration Area. In the fall of 1935, advantage was taken of an opportunity to stock this area with cattle. 75 cows and 3 bulls were placed in the area at that time. A re-survey of the area was made in the spring of 1936 and it was found that the present car-

rying capacity of the area is 164 head of cattle, so that at the present time the range is stocked to approximately half of its carrying capacity.

For the purpose of range management, a cross fence was constructed separating winter and summer range, which also allows for the segregation of bulls except during the breeding season. A corral has been constructed and sufficient water has been developed to permit proper distribution of stock.

The results shown by the Mariana Lake demonstration area are rather astounding. Range recovery has been rapid and a high degree of erosion control has been obtained. In fact, there has been no runoff out of the area during the past year.

Gamado Demonstration Area. The Gamado demonstration area was stocked during the month of August 1935, with 397 head of ewes belonging to Indians living within and adjacent to the area. In November, 12 high grade rambouillet rams were purchased by the owners of the ewes and placed in the area. A herder, under the direct supervision of the range foreman, has been with the sheep continuously and has maintained proper management, following the best animal husbandry practices at all times.

The bucks were segregated from the ewes, except during the breeding season commencing December first. The lambs all arrived during a period of about five weeks, starting early in May. 371 lambs were produced by 396 ewes, which represented a lamb crop of 93% as compared to an average of 50% or less on the outside. The increased lamb production is largely attributed to the increased forage which was efficiently utilized through the application of sound herding practices.

The rams and ewes were sheared in June and showed the results of an ample food supply during the winter. The majority of ewes are fairly well improved by crossing with rambouillet rams. All but one of the owners represented have sheep both within the area and on the outside. There is no noticeable difference in the grade of the animals in the bands grazed within the area and those outside, however, there was a marked difference in the wool clip. The average fleece weight from the ewes within the area was 8.17 pounds, while the best available

estimates indicate that the average for the sheep on the over grazed outside ranges was four pounds or less. One man who keeps accurate records sheared an average of six and one half pounds of wool per head on the sheep grazed outside of the area, while those he owned in the area band averaged 8.9 pounds.

Frazer Demonstration Area. Due to the small size and low carrying capacity of this area, it is impossible to graze it with a breeding herd of economic size. It was, therefore, decided to use the area as a community buck pasture so as to allow the Indians in this vicinity the opportunity of practicing controlled sheep breeding. It has been the common practice in the Navajo country to allow the bucks to remain in the breeding herd year-long which results in a very uneven aged lamb crop and results in an economic loss to the producer.

168 rams were placed in the area in October 1935. It was stipulated that all owners placing bucks in the area bring in all the bucks owned and not to allow any other rams to run with their breeding herd. The owners were allowed to take the bucks out of the area during the period December first to January tenth and to place them in their bands for breeding purposes.

The rams were sheared in June and the wool turned over to the owners. As most of these bucks were of rather low grade, the wool clip was not very heavy. A few of the better rams sheared from 24 to 35 pounds, while the majority of the Navajo rams sheared from 4 to 16 pounds with an average clip of 7 pounds. It is hoped that during the present year many of the older and poorer grade rams can be replaced by younger animals of better breeding.

At the time of the establishment of this area, much of it was in an advanced stage of depletion and erosion was very severe. Due to past abuse and unfavorable climatic conditions, the vitality of the vegetation was extremely low. Since control has been obtained, there has been a marked improvement in vegetation, in spite of the continuation of unfavorable climatic conditions.

Klag-E-Toh Demonstration Area. Since this area is primarily an agricultural development, the principle objective of range management is to provide the means for maintaining the highest possible yield of the necessary forage required to take care of the work stock that will

be used in the development of the agricultural resources. Following out this plan, the area was stocked to the carrying capacity with 55 head of work horses in the fall of 1935.

Climatic conditions within this area have been unfavorable within the past year, but in spite of this the range is showing some recovery under the range management program.

Rayenta Demonstration Area. An intensive grazing survey of this area was completed during the summer of 1935, but due to the lack of water development, the area was not stocked until the spring of 1936. The water development program has not as yet been completed and for this reason the area has not been stocked to its full capacity of 1,045 head. It is expected that the stocking will be kept down until adequate water is available. Climatic conditions have been extremely unfavorable in the Rayenta region during the past year or so. A large portion of the adjacent territory is in critical condition and the demonstration area has shown little or no improvement under total protection.

Outside the Reservation, range management studies have been made for five special areas or projects, including Concho, Coyote Creek, Snowflake, Knickerbocker Arroyo, and the Glade demonstration area.

Concho Area. In the vicinity of Concho, 6,651 acres have been placed under range control. This area has a carrying capacity of 63 cows year long. Surveys have been completed and cooperative agreements have been signed.

Coyote Creek. This area lies about four miles east of Springerville, Arizona, next to the New Mexico state line on the upper head water of Coyote Creek adjoining the Apache National Forest and includes an area of 33,000 acres. The stockmen within this area are at present practicing creditable grazing systems and are favorable to the control measures which have been suggested.

Snowflake Proposed Area. A range survey of this area in-

cluding some 50,000 acres has been completed, but owing to the unfavorable attitude of the livestock owners, a range control program has not been put into effect.

Knickerbocker Arroyo. An extensive range and erosion survey of an area comprised of 6,568 acres has been completed. Range control has not been put into effect to date, but it is expected that the attitude of the land owners will be favorable.

Glade Demonstration Area. A range survey has been completed on an area comprising some 25,600 acres. This land is badly in need of range control but due to the long narrow shape of the area and the excessive cost of fencing, this may be difficult to accomplish.

c. There has been no accurate inventory of the forest areas and timber resources on the Navajo Reservation, however, it is estimated that the timbered area covers approximately 2½% of the Reservation. The relative abundance of the various species is approximately as follows;

Ponderosa pine.....	34.50%
Douglas fir.....	0.00%
Engelmann spruce.....	0.30%
Pinon pine.....	38.32%
Juniper.....	25.00%
Miscellaneous.....	1.00%

On the basis of the available information in regard to the forested areas, it is recommended that the management be directed towards watershed protection with a limited amount of domestic and commercial utilization. The type of forest by districts and the highest use for land management purposes is indicated below;

Carrizo Mountains, Pinon-Juniper, Watershed protection
Lukachukai Mountains, Ponderosa pine-fir, Watershed protection with limited lumbering operation.
Lukachukai Mountains (foothills), Pinon-Juniper, Watershed protection.
Chuska Mountains, Ponderosa Pine, Watershed protection with limited lumber operation.
Defiance Plateau, Ponderosa Pine, Commercial lumbering operation.
Defiance Foothills, Pinon-Juniper, Watershed protection.

Westfields-Whiskey Creek, Ponderosa Pine, Commercial lumbering operation, watershed protection.
Black Mesa, Pinon-Juniper, Watershed protection.
Navajo Mountain Lower Slopes, Pinon-Juniper, Watershed protection.
Navajo Mountain (higher elevations) Ponderosa Pine Englemann Spruce-fir, Watershed protection.

Little progress was made in the general forest improvement program until January of this year, due to the lack of an adequate personnel. Since that time a definite beginning has been made in a program of forest improvement. It appears that range control is the greatest single factor in forest improvement on the Reservation and, therefore, the range management and forest management program must be closely coordinated. The principle activities in the forest improvement program have included:

1. Collection of data for volume tables.

2. Establishing permit system for cutting timber.

3. Marking timber in order to insure protection where needed.

4. Proper disposal of brush to lessen fire hazard.

5. Regulation of cutting.

6. Reduction of fire hazard through clearing for roads and telephone lines, etc.

7. Instruction of Indians in better timber utilization.

8. Organization of Indians for fire detection and fire suppression work.

9. Establishment of new lookouts.

10. Improvement of logging methods, especially with reference to erosion control and protection of reproduction.

11. Planting of arborescent species for control of erosion.

12. Improvement of saw mill operations.

By far the greatest portion of the timbered area on the Reservation is occupied by pinon juniper woodland. These two species have made the greatest contribution to the comforts and welfare of the Indians. They furnish fuel and building material. For these reasons, particular attention has been given to the protection and improvement of the woodland stands. Very little information is available from other sources in regard to growth management and utilization of this woodland type; it was therefore necessary to make certain basic studies in order to develop a program for woodland management. Preliminary studies have been completed to provide the necessary information for growth and volume tables, and studies are being made on reproduction of woodland species with particular reference to damage by grazing and fire.

Some progress has been made in the development of a program for improvement of the Ponderosa pine stands. The two most important phases of the problem in the saw timber areas are the establishment of reproduction and the removal of over matured and decadent trees. Because of its isolation, a considerable portion of the forested area can not be utilized on a commercial basis and its chief value lies in watershed protection. Through range control and a limited amount of cutting for local consumption, it is hoped that these areas can be maintained in a healthy condition to provide adequate cover for watershed protection.

f. Revegetation on the Navajo District has been an important part of the agronomy program. An attempt has been made to confine the revegetation operations almost entirely to native species of the different plants in order to more nearly assure success; however, small numbers of plants which might be considered exotic have been used in an experimental way. The following list includes the varieties and amounts of plants and seed used in the revegetation program for the year:

Kinds and Amounts of Plants

Box elder - Acer negundo	905
Bush mint - Poliomintha incana	1,180
Caragana arborescens	325
Chamiso - Atriplex canescens	16,7[illegible]
Cliff rose - Cowania stansburiana	5,519
Cottonwood - Populus (wislizeni)	29,607
Elm (American) - Ulmus americana	4,600
Elm (Chinese) - Ulmus pumila	39,143
Forestiera neomexicana	23,430

Grape (Concord) - Vitis labrusca	2,175
Greasewood - Sarcobatus vermiculatus	250
Hackberry - Celtis reticulata	4,993
Iuka - Thrapsites sp.	30,610
Locust (Honey) - Gleditsia triacanthos	37,907
Locust (New Mexico) - Robinia neomexicana	275
Mountain mahogany - Cercocarpus montanus	4,000
Olive (Russian) - Elaeagnus angustifolia	21,759
Purryella filifolia	4,251
Parosela sp.	10,041
Plum (Wild Goose) - Prunus sp.	15,026
Mulberry (Russian) - Morus alba	17,304
Squaw Berry - Rhus trilobata	135
Tamarisk sp.	172,772
Virginia Creeper - Psedera quinquefolia	150
Walnut (Black) - Juglans nigra	3,209
Willow - Salix sp.	83,515
Winter Fat - Eurotia lanata	750
Wolf Berry - Lycium pallidum	5,070
Yucca baileyi	950

Kind and Amounts of Seed

Alfilaria - Erodium cicutarium	lbs.	9,000
Brome Polyanthus	"	304
Chamise - Atriplex canescens	"	5,437
Grass (Blue) - Bouteloua gracilis	"	2,338
Kentucky Blue grass - Poa pratensis	"	870
Poa bulbosa	"	8,363
Rye	"	1,710
Sage (Black) - Artemisia tridentata	"	40
Sage (Sand) - Artemisia filifolia	"	480
Sacaton - Sporobolus airoides	"	4,076
Sweet Clover - Melilotus officionalis	"	257
Western wheat grass - Agropyron smithii	"	77,185
Wheat	"	219
Winter Fat - Eurotia lanata	"	724
Walnuts (Black) - Juglans nigra	"	140

Revegetation has been somewhat restricted due to the limited amounts of desirable plants and seed available, especially of the native varieties. This work, so far, has been confined to the most strategic sites, particularly since planting materials have been the limiting factor in the expansion of the program. The scope of this work is as follows:

forestation, acres	114
gully planting, acres	1,246
bank protection, square yds	1,306,803
revegetation, acres	8,423

Since the field work in revegetation started prior to the establishment of Soil Conservation Service nurseries, it has been necessary for the District personnel to collect a part of the planting material which was used. During this fiscal year, 78,000 cottonwoods, 334,700 tamarisk, 81,600 willows, and 30,610 Iuka plants were gathered and 240 pounds of blue grama, 750 pounds of chamise seed were collected for use on the Navajo District. In addition to this, 255,600 cottonwoods, 135,000 tamarisk, and 415,300 willows were collected for the Rio Grande District.

During the past year, various agencies on and near the Reservation have requested small numbers of plants or trees for special purposes. A total of 10,750 trees and other plants were furnished to some of the agencies on and near the Reservation in small amounts for various types of revegetation work.

g. The concentration of runoff caused by highways, wagon roads, and stock trails, due to over grazing, has resulted in much of the erosion on the Reservation. Under the head "brief description of work areas", several highway projects have been described wherein treatment has been given to existing roads or to those formerly used and now discarded. This treatment in general has consisted of proper drainage and spreading of water so as to stop undue concentration. Where concentration has occurred because of highway structures, an attempt has been made to spread this water below the highways so as not to cause gullying.

On secondary roads and trails "thank-you-ma'ms", in conjunction with diversion dikes and ditches, have been used to deflect the water from the road. In many instances, water so deflected has been spread over adjacent country or used to irrigate road-side plantings.

On the demonstration areas, road construction has been made part of the regular program and only approved practices followed. The Soil Conservation Service has assisted in the proper location and approval of highways and trails over the Reservation. Proper width of clearings and handling of brush has been urged in all new construction.

BRIEF DESCRIPTION OF WORK AREAS

The location of the various work areas is shown on Plate 4 and the areas are listed in Table IV which also indicates the type of area, the land management unit in which it is located, and the acreage treated or affected. The erosion conditions, objectives of work, progress, and other essential features in regard to these work areas are briefly discussed below.

Cedar Ridge:

This project, indicated as No. 1, Plate 4, is located about 36 miles north of Cameron, Arizona on the west side of Highway 89. Erosion control work has been completed on approximately 10,000 acres. The numerous small finger gullies were treated with brush plugs; and water was diverted and spread by means of earth diversion dams, earth dikes, and spreader fences. The project was started November 1935 and completed in April 1936. The area is not fenced and is subject to heavy grazing, but the local residents have promised to improve their range management.

Kaibito:

An area of 10,000 acres, indicated by No. 2, Plate 4, located near the Kaibito Trading Post, subject to moderately severe gully erosion, was treated with woven wire and brush spreader fences, earth water spreading dikes, and gully plugs. The principle objective for this project was to secure needed erosion control for the protection of roads and buildings. It was a small job and was completed during the winter months.

Piute Canyon:

This demonstration area of 6,260 acres, shown on Plate 4 as No. 3, is located about 105 miles north and east of Cameron, Arizona. This area, which includes about 160 acres of farm land, lies along Piute Creek which is a tributary of the San Juan River.

The demonstration area is bounded by a vertical escarpment on three sides. The canyon floor proper is about one mile wide. Piute Creek which runs through the valley floor has cut a channel to a depth of from ten to thirty feet and is a meandering wash one hundred to three hundred feet wide which in times of flood does serious damage by cutting the banks. The creek has a continuous flow

TABLE IV

NAVAJO DISTRICT WORKING AREAS

No. of Area or Project	Name of Area or Project	Location By Land Mgt. Units	Acres Treated or Affected	Type Area or Project
1	Cedar Ridge	1	10,000	Highway
2	Kallito	1	10,000	Highway
3	Pinto Canyon	2	6,250	Cooperative
4	Emerirldon House	2	1,000	Highway
5	Moen Ave	3	10,500	Demonstration
6	Red Lake	3	22,000	Cooperative
7	Canyon Diablo	5	1,124	Demonstration
8	Lower Chinlitto	5	800	Cooperative
9	Tonsa Canyon	6	25	Stream Protection
10	Pete Springs	7	25,100	Demonstration
11	Tsaile Valley	8	5,120	Cooperative
12	Chilchinbito S.R.A. #1	8	5,000	Highway
13	Chilchinbito S.R.A. #2	8	2,150	Highway
14	Chilchinbito Demonstration	8	16,525	Demonstration
15	Lukachukai	8	331,112	Land Management
16	Rayenta	8	30,223	Demonstration
17	Tsee Nas Pas	9	200	Cooperative
18	Canyon de Chelly	10	3,171	Demonstration
19	Salina	10	7,162	Special
20	Burlial Road	10	1,120	Highway
21	Cola Lee Road	10	700	Highway
22	Fraser Demonstration	10	5,522	Demonstration
23	Ishchabal	11	225	Cooperative

TABLE IV (Continued)

No. of Area or Project	Name of Area or Project	Location By Land Opt. Units	Acres Treated or Affected	Type Area or Project
24	Cove Demonstration	12	29,276	Demonstration
25	Highway 666-1	12	92	Demonstration
26	Highway 666-2	12	176	Demonstration
27	Gilbrook Bureau	12	100	Cooperative
28	Red Rock Road	12	3,125	Highway
29	Holbrook	12	1,160	Cooperative
30	Fruitland	13	3,600	Cooperative
31	Five Quarters	14	65,000	Land Management
32	Cheo Canyon	15	2,000	Demonstration
33	Kirkwood	15	24	Cooperative T.V.A.
34	Tarkio Lake	16	7,000	Demonstration
35	U. S. R. 10	16	100	Special Highway
36	Hillshed	17	2,030	Cooperative
37	Stemlock Canal Road	17	2,000	Highway
38	Stemlock Area	17	25,000	Demonstration
39	Hay-Fish Area	17	2,000	Demonstration
40	Purple Road	17	605	Highway
41	Canal Area	17	1,022	Demonstration
42	St. Michaels	18	210	Cooperative
43	U. S. R. 15	18	6,020	Cooperative
44	Oak Orchard	18	2,000	Cooperative
45	Hwy. 6 Hwy	18	67	Demonstration
46	Conco Area	19	2,000	Cooperative
47	Naylor Reservoir	4	67	Demonstration
48	Star Ditch	4	No area	Project (Protection)
49	North Burlington Ditch	4	No area	Project (Protection)
50	Whitewater Arroyo	4	No area	Project (Protection)
51	Upper Pecos	4	33,000	Demonstration

(Continued) TABLE IV

of from one quarter of a second foot to two second feet.

The inhabitants of the canyon live upon the plateau during the winter and in summer return into the canyon to do their farming. They divert the flow of the creek, but the works are very inefficient and much of the water is lost. This poor handling of the irrigation water with inadequate ditches and turnouts has been a large cause in erosion, making much of the land unfit for cultivation.

The Indians living within the area or farming land within the area have shown a good spirit of cooperation. They have purchased a number of fruit trees and have planted them according to the advice of the Soil Conservation Service representative. Most of the flocks are of a subsistance size and no large flocks of sheep are owned by the inhabitants of the area.

The primary objective of the work within the area is to protect the farms from erosion and to improve the irrigation system with adequate diversions and a system of ditches and turnouts so that efficient use can be made of the limited water supply. Also, to prepare the land so that good farming practices can be followed as well as to protect the soil from washing.

About 8,000 feet of main irrigation canal has been constructed which makes it possible to get the water to the land for use. Drops and turnouts have been provided. Flumes across gullies have been constructed and flood protection from the runoff from adjacent canyon walls has been provided for the system of ditches. Rock jetties have been constructed in the channel to protect the farm lands from danger of erosion during times of high flood.

Inscription House:

Number 4 on Plate 4 refers to this work area which is located along the Red Lake - Inscription House road about 35 miles east of Tuba City, Arizona. Approximately 1,800 acres are affected by the erosion control measures. Located in a high plateau country at an elevation of about 6,500 feet and with a sparse vegetative cover dominated by big sage, this area is subject to considerable erosion.

The road in this vicinity follows down long slopes which have a long runoff and the road often intercepts small washes and carries the water down the slope where it is lost to any beneficial use to the range as well as doing damage to the road. The slopes in this area are badly cut up with two and three foot gullies that quickly carry all runoff down to the road where it is in turn carried along great distances before it is naturally diverted from the road ditch onto the range.

While there are some large herds of sheep in this vicinity most of the flocks are only of a subsistence size. The people are very favorable to any work that is done in this area and are willing to cooperate with the Soil Conservation Service in any undertaking.

The primary object of the work in this area was to protect the road from erosion and to prevent the loss to the range of the runoff that was occurring, as well as to prevent the small gullies from increasing in size.

The project was started in November 1935 and due to curtailment in forces was temporarily discontinued January 1, 1936. Earth gully plugs were built across the gullies and the flow diverted onto the range. Wire and brush spreaders were used at the spill end of the earthwork. Earth dikes were built running from the road ditch for a distance from the roadway onto the adjacent range then supplemented with wire and brush spreaders to carry the water from the spill of the earth dike and spread it over the land in such quantities that erosion will not be induced. The road was protected from water forming in the low spots and creating mud holes.

Moen Ave:

The Moen Ave demonstration area, indicated by No. 5 on Plate 4, is located twenty-three miles northeast of Cameron, Arizona. The east boundary lies just west of Tuba City Trading Post. The area extends westward approximately six miles along the Flagstaff-Tuba City road. There are about 10,508 acres in the area which is under fence.

The area includes two distinctly different types of country. There is an escarpment of Navajo sandstone that extends the entire length of the area almost dividing it in two. Behind the escarpment is typical plateau country covered with black brush and very little grass. Below the escarpment at an elevation about two hundred feet lower is the valley. Practically all the vegetation on the lower land has been destroyed and sheet and wind erosion has removed all of the top soil down to a hard subsoil that is very impervious and unproductive. Runoff from this portion is excessive. The soil upon the plateau is very sandy and is not productive of much runoff. A number of small springs, ranging in capacity from seeps to eighteen gallons per minute, emerge from the face of the escarpment for its entire length. The water from these springs has been used by the Indians to irrigate small patches of land lying along the foot of the escarpment.

Because of a depleted condition of the range within the area

before it was fenced and protected from grazing, the runoff from the plateau is larger than should be expected. This runoff, pouring off the escarpment, run through the small farmed areas and has caused serious gully erosion and destroyed land where it can not be spared since irrigable land is so scarce. Wind erosion is extremely serious in this district. Large sand dunes are present which are migrating towards the face of the escarpment and threaten to encroach upon the limited farm lands.

The primary objectives of the work within the area were the development of the larger springs and to gather the several flows and convey them to storage reservoirs which have been constructed in order to furnish a larger quantity of water for an irrigation head; to improve the existing farmed tracts and prepare additional potential lands for irrigation; to construct an irrigation system consisting of ditches and appurtenances; to provide flood protection for the farm lands and the irrigation system from runoff from the plateau above the escarpment; to check the head erosion in the farm lands and do range erosion control work and water spreading to improve the general condition of the range cover; and to construct artificial barriers on sand dunes in an attempt to stabilize them long enough for vegetation to become established.

About 45 acres of land have been subjugated for irrigation, a water supply developed, and storage provided to furnish the land with irrigation water. The entire irrigation system and the farm lands have been protected from any runoff that might occur from the areas above the system. Erosion control and water spreading has been carried on. The improvement of the range cover within the area is very apparent. Sand barriers have been constructed on a number of the encroaching sand dunes to protect the farms from becoming covered up with sand. The barriers have enabled some vegetation to become established in the sand. Work was started in February 1935 and is about 90% complete.

Red Lake:

This area of about 22,000 acres, indicated by No. 6 on Plate 4, is located about 25 miles east of Tuba City, Arizona, along the Red Lake-Kaibito road. The area consists of a small valley which carries the runoff from long slopes of five to fifteen percent, extending back to the steep plateau country of White Mesa. Overgrazing has removed so much of the vegetative cover that erosion has started in the form of gullies two to five feet deep and eight to twenty feet wide. These gullies run both down through the center of the valley and laterally down the slopes towards the main gully. Any runoff occurring soon enters these gullies and is lost to any beneficial use.

The attitude of the inhabitants of this vicinity was very favorable towards the work within the area. Many of the flocks are of a subsistence size and the income of the people needed to be supplemented with a cash subsidy.

The objective of the work in this area was to check the progress of head erosion and to divert the runoff carried by the gullies on to the adjacent range lands. By doing this, the runoff along the roadway was diverted away from the road and put to beneficial use on the range land.

The project was started in November 1935 and because of a curtailment in work forces, it was discontinued January 1, 1936. Earth gully plugs were built in the smaller gullies to divert the flow onto the range. Wire and brush spreaders were provided at the spill end of the earthwork. Earth dikes were built around the heads of the larger gullies and water excluded and spread over the range using wire and brush spreaders. Thank-you-ma'ams were constructed across the road at intervals so as to check runoff following in the ruts of the road and to turn it onto the adjacent land where it could be absorbed and put to a beneficial use. About 16 percent of the area was completed.

Canyon Diablo:

This project, shown as No. 7 on Plate 4, is located on both sides of the road leading from Highway 66 to the Leupp Indian Agency. It lies just north of the southern boundary of the Reservation and south of the Little Colorado River. An area of 4,864 acres has been fenced, treated, and closed to grazing. The vegetative cover is very sparse, consisting mostly of various species of salt bush and saaton. The mud flats, which are the conspicuous features of the terrain, have been subjected to sheet erosion to a degree favorable to the development of incipient gully erosion.

The main objective of the work was to control the sheet erosion to prevent the further development of gully erosion and to bring about range improvement. The project was started in October 1935 and completed in April 1936. Earth dikes were built across the depressions in the mud flats with spreaders of wire and burlap at the spill end of the dike. The small gullies were controlled by plugs and check dams.

Lower Dinnebito Cooperative Area:

This agricultural area of 800 acres is located on the Leupp extension about 15 miles northwest of Tolani Lakes and 25 miles north of Leupp. It is indicated by No. 8 on Plate 4.

About one hundred acres of this area is cultivated and it is for the protection and development of this agricultural land that the project was initiated. There is considerable wind erosion but very little water erosion.

The Navajos in this district are very self-reliant. With no knowledge of modern irrigation or engineering they have constructed a workable irrigation system. They appreciate the value of technical supervision, however, and have signified their willingness to donate labor in order to improve this irrigation system if the necessary supervision is provided.

The plans at present are to assist them in utilizing all available water in their reservoir on their crops this year by lowering their outlet ditch and renovating their existing system of laterals. In order to protect the dam which provides this water, it will be necessary to enlarge and deepen the existing spillway as a protection against floods.

Tentative plans have also been made to rebuild the dam, construct a spillway to the large flats to the east, and construct an erosion proof irrigation system for the farm land to utilize both live water and floods.

Work was started on this project June 1, 1936, and by the end of the month was 60 percent complete. No special erosion control structures have been necessary. The principal accomplishment has been the lowering of the main ditch and spillways and revamping the laterals to improve the grade.

Keams Canyon:

This erosion control project (No. 9, Plate 4) is located in Keams Canyon above the Hopi Agency headquarters. This is a small project involving about 20 acres which has been fenced, although the fence has not been entirely effective in keeping out livestock.

The principal objective of the work was to control side cutting and sloughing in the Keams Canyon arroyo. The work included revegetation, forestation, and the construction of jetties.

This work was completed more than a year ago and there have been no erosion control activities within the area during the past year.

Pete Springs:

The watershed area of the Bashbito Wash, including approximate-

by 23,400 acres, located west of the Steamboat Canyon demonstration area and indicated by No. 10 on Plate 4, presents a serious erosion control problem. The entire watershed is over grazed, and the two forks of the main wash, with their feeder gullies, are taking a heavy toll from the area.

The Indians living along the wash farm the delta of the wash and graze their small flocks in the upper part of the watershed. The poor range conditions and the uncertainties of their farming operations have rendered them willing to cooperate in any scheme that the Soil Conservation Service may think fit to better their condition. The labor on the work is partly paid and partly donated.

The primary objective of the work is the rehabilitation of the range and the protection of the farm land from floods.

The project was started in April, 1936, and is about 30 percent complete. 830 acres have been treated for erosion control. Some work done by the I.E.C.W. in the early part of 1935 was revamped; two rock drops for controlling head erosion have been added for safety. Small brush dams have been built in the upper part of the watershed. Six diversion dams have been built of earth across the main wash and the diverted water has been carried behind 2,500 linear feet of earth dikes and spread over adjacent range lands. A stock watering shallow reservoir has been constructed in the bed of an old dry lake and water diverted to the reservoir. Dikes of earth have been built above head erosion sites and the water spread over range land. The earth structures have been seeded to grass.

Monument Valley:

This erosion control area of 5,120 acres (Plate 4, No. 11) is located about 23 miles north of Kayenta along the Kayenta-Bluff City highway and along the Arizona-Utah boundary. The area consists of gently rolling slopes down which small gullies have formed as a result of the excessive runoff from the over grazed range lands.

The people in this vicinity are small stock owners and are very anxious to cooperate in order to secure financial assistance and to secure the advantages of erosion control and range improvement.

The primary objectives of the work within this area were to check the progress of the head erosion, to spread the runoff carried by the innumerable small gullies onto the adjacent range lands and to protect the Kayenta-Bluff City road from damage caused by excessive runoff.

The project was started in November 1935 and completed January 1, 1936. Earth gully plugs were built across the washes and spreaders of wire and brush were used at the spill end of the plugs to keep the water spread out. Earth dikes were built across the low section and starting gullies. Spreaders were provided at the spill end of the structures.

Chilchinbito - Special Erosion Project No. 1:

This project (No. 12 on Plate 4) extends along the Chilchinbito-Chin Lee road from the southern boundary of the Chilchinbito demonstration area. The area affected consists of about 54,000 acres.

This project is primarily for road protection, but includes the spreading of water over the adjacent range land. The road, itself, which crosses long, rolling, grass covered slopes, is directly responsible for much of the erosion. The road is long and straight, intercepting many small washes and conveying the water down the roadway, resulting in erosion which has necessitated, in a number of places, moving the road onto new ground.

The people in this vicinity were favorable toward the work. The primary objective of which was to protect the road from further cutting and to utilize the runoff by taking it away from the road and spreading it on the range. About 25 miles of road was treated by building "thank-you-ma'ams" at intervals frequent enough to prevent much water concentrating in the road. Earth dikes were built above the road to keep the runoff from reaching the roadway, and dikes were built below the road so that any water discharged from the roadway would be spread and absorbed.

The project was started in November 1935 and completed in January 1936.

Chilchinbito - Special Erosion Project No. 2:

This project, designated as No. 13 on Plate 4, is located near the Chilchinbito-Chin Lee road, about 9 miles east of Chilchinbito. The area of the project is about 2,450 acres.

The area consists of gently sloping land bounded on the upper end by sandstone cliffs from which runoff is excessive. Below the cliffs is slick land and mud flats which do not absorb runoff. At the lower end of the flats a ten foot active cutting gully head is rapidly encroaching upon the road. During the past year, the road has necessarily been shifted over away from the breaking bank. Run-

off has concentrated in the low section of the flats and started to cut small shoe string gullies which empty into the large gully head.

The people in this vicinity are quite poor, having but small subsistence flocks. Their attitude is generally favorable toward the work that has been done in their area and they are willing to cooperate with the Soil Conservation Service in carrying on any work.

The primary objective of this project was to halt the severe head erosion that was causing the road to be shifted in order to keep it clear of the gully head. Also, to derive some beneficial use from the runoff rather than have it quickly enter the gully and rapidly run out of the country.

The project was started in December 1935, and completed in February 1936. Earth dikes were built near the toe of the slope of the cliffs and in the flats to hold any runoff from entering the small gullies and to carry it onto sandy soil where absorptive qualities were better. Earth dikes were also built immediately above the main gully head to exclude any runoff from entering it and aggravating the condition. Wire and brush spreaders were used at the ends of the dikes to keep the water spread out over a large area and at the same time permit quantities of water to pass over the land below the dikes. Earth gully plugs were built across the small gullies to divert water carried by them onto the range. Wire and brush spreaders were used at the spill ends of the gully plugs.

Chilchinbito Demonstration Area:

The Chilchinbito demonstration area (No. 14 on Plate 4) includes some 16,536 acres and is located about 24 miles southeast of Kayenta, Arizona. The area lies along the east side and near the slope of Black Mountain. Three large gullies heading on the mesa run through the area, which varies topographically from 3 to 15 percent pinon juniper covered slopes to one percent slopes with grass land predominating. The three principal gullies have many small tributary gullies. Head erosion is common in the grass land areas, due to the depleted condition of the vegetative cover.

The people living within the area are barely making a subsistence from their flocks. The general attitude of the people is favorable toward the work.

The principal objectives of the work were to re-establish the range vegetation, check the head erosion, stabilize the grade of the main gullies where it appeared that they were beginning another cycle of deepening, and to spread water over the range where ever possible.

The project was started in July 1934 and completed in April 1936. The area is fenced and all livestock have been excluded. Rock check dams were built in some of the arroyos and in some of the gullies in order to hold back runoff and permit stabilizing of the gullies until vegetation and trees could become established. Different types of spreader structures have been used in order to determine the advantages of each, and under what conditions each was applicable. Earth dikes have been built across some of the low depressions and around a number of the heads of gullies. Runoff that would normally enter these gullies and be lost to use is now spread over the range.

The range has shown a decided improvement as a result of protection from use, together with the additional moisture penetration that was gained by checking water that fell upon the ground where it occurred, in addition to the increased amounts that some parts of the range received from water spreading.

Dennehotso:

The Dennehotso land management area (No. 15, Plate 4) located about 28 miles east of Kayenta, Arizona, includes the Dennehotso Chapter, comprising approximately 331,412 acres. The Dennehotso Chapter is one of those within the Monument land management unit. The proposed treatment within this area is a part of the land management plan for this unit.

This area embraces all types of country, ranging from fertile flat valley along Laguna Creek to rough, broken sandstone rock hills. Much of the area is waste land upon which no vegetation grows. The vegetative cover on the remainder of the district has been greatly depleted by over grazing. Near the center of the area and lying on both sides of Laguna Creek is a fertile valley that has been cultivated by the Indians. Laguna Creek is shallow at this point and a diversion dam has been constructed by the U.S.I.S. which enables the farmers to divert the steady flow from the creek for irrigation. The diversion and a short section of main canal was all that was built. The balance of the work of delivering the water to the land was left up to the Indians. The result has been a haphazard layout of the different fields of all shapes and a very intricate system of many small irrigation ditches. The land has had hardly any preparation for irrigation. Poor irrigation practice prevails with the result that there is a waste of irrigation water, even though it is so scarce that very often broken land is not planted, due to shortage of water. There has been under cultivation at Dennehotso about 700 acres. The steady flow in the creek ranges from about one-half second foot in the early summer to four second feet during the winter and spring months.

The meandering Laguna Creek threatens serious damage to the valuable farm land throughout this area. Improper irrigation practices contribute to erosion from above, and as a result, side gullies are cutting back into the farm land. Outside the farm land, erosion consists mainly of slight gullying, but extensive sheet and wind erosion.

The attitude of the people in this district is very favorable towards the plans of the Soil Conservation Service. The people are generally in poor circumstances. There are some large flocks but many of the people own no sheep or only small subsistence flocks.

The primary objectives of the work in this area were to improve the existing farm lands by proper subjugation of the lands, to obtain as great use as possible from the present limited water supply, to develop additional potential farm land if the supply of irrigation water should warrant any expansion, to protect the farms from being encroached upon by the head erosion caused by waste water breaking through the shoulders of the inadequate borders and running into the creek over its banks, to check head erosion along Laguna Creek caused by inflowing runoff, and to divert runoff from the gullies and spread the water onto the range.

The project was started in September 1935. It is now about 15 percent complete.

About ten thousand feet of irrigation ditch has been built. A tract of about seven acres has been subjugated as a demonstration. Flood protection and bank protection have been carried on, amounting to about four miles of earth embankment, averaging a yard per foot. About 1500 feet of sand barrier has been built to protect the main irrigation canal from filling up with blow sand. On the range outside the farm lands an earth embankment has been built along portions of Laguna Creek where inflowing runoff entered the creek and was causing serious head erosion. Earth embankments have been built across small gullies and the water that normally flowed in the washes and continued into Laguna Creek and was lost is now spread over the range land to increase the moisture received by the range.

Hayenta:

The Hayenta demonstration area (No. 16, Plate 4) extends from a point three miles west of Hayenta along the Hayenta-Tuba City road for a distance of approximately six miles. From this line, the area extends about ten miles north and covers an area of approximately 30,223 acres. Approximately 50 percent of the boundary has been fenced, while the remainder is a natural boundary.

The western boundary is composed of a high sandstone cliff. Following along it for a width of one and one-half to two miles is a strip of land with slopes from vertical to 30 percent. The cover is a sparse growth of trees with very little brush or grass. The central, north and southern parts of the area have a large percentage of exposed sandstone. The cover is grass, trees and shrubs. Drainages generally follow between sandstone cliffs with narrow valleys, and gullies cut to a depth of 20 to 40 feet in the soil. The south part of the area is composed of wide flats along the banks of Laguna Creek. Gullies are cutting this area to depths of one hundred feet.

The entire area is badly cut by gullies. Spots have been about eroded to the heavier subsoils, leaving little or no vegetation. Wind erosion is serious, due to the condition of the vegetative cover. About three miles in the center of the area are covered with large sand dunes. Runoff from the more barren slopes of the western and northern sections of the area has cut numerous gullies in the relatively level section bordering the Laguna Creek.

The objective of the engineering work is to control the runoff from the steeper slopes by dikes and to throw the water out of actively cutting gullies so that it can be used for the purpose of range irrigation. This work is to be carried out chiefly along Laguna Wash. While there is much work to be done toward gully control over the rest of the area, the larger percentage of it will be handled by range management methods. Planting plans are complete for aiding in gully control and revegetation. Wind and sheet erosion are to be controlled by revegetation.

To date, about 20,000 acres have been affected by gully control and water spreading. These two methods have been combined as much as possible with the removal of water from actively cutting gullies and using it for range irrigation.

Work was started on this area December 4, 1934, and to date is about 50 percent complete.

Teec Nos Pas:

This project (No. 17, Plate 4) lies adjacent to the Teec Nos Pas day school situated about nine miles southwest of Four Corners, and covers approximately 900 acres. Severe gully erosion is destroying valuable farm land and threatening the school area. The Indians along the sides of the arroyo have displayed a very cooperative spirit and have donated their labor. The people in this district have no large flocks of sheep and goats but depend on farming for their

livelihood. The work was undertaken with two main objectives in view, first, control of erosion on both day school and farm lands, and the other, the proper distribution of water for irrigation purposes.

The project was carried out in cooperation with the Indian Irrigation Service who supplied supervision and cement. The project was started in November 1935 and completed in March 1936. One earth diversion dam was constructed in conjunction with a canal distribution system installed with suitable masonry drops, checks, turnoffs and gates. One masonry diversion dam with connecting canal was constructed. Small rock check dams were built in the smaller arroyos around the school and dikes were built along the arroyo bank to protect both school and farm land.

Canyon de Chelly:

The Canyon de Chelly demonstration area (No. 18, Plate 4) is located within the canyon walls of Canyon de Chelly, Canyon del Muerto, and Black Rock Canyon, all lying within the Canyon de Chelly National Monument near Chin Lee Indian Agency. The area included within the project is about 3,137 acres.

The Indians living within the area have shown a good spirit of cooperation. They have bought fruit trees in quantities and have planted and cared for them according to the advice of the Soil Conservation Service representative on the job. The Indians in this area are largely dependent on agriculture for a living.

The primary objective of the work within the canyons was the saving of the agricultural lands from being entirely washed away by the flood runoff in the washes.

About 1,100 acres of good farm land has been subjugated and put under flood irrigation. The smaller side washes have been diverted by the construction of earth or masonry dams and canals have been built to carry the flood waters to the farms. Rock masonry drops, headgates, intake gates, etc., have been built. Many of the farms have been terraced. Rock jetties and fences have been built in the main channels to prevent further washing of the farm lands by the flood runoff.

The work was started in February 1935 and is about 75 percent complete.

Salina:

This project (No. 19, Plate 4) is located south of the Salina

Trading Post in a valley which extends from the Balaid Mesa on the west to the Salina-Gamado road on the east. The project covers approximately 7,162 acres.

This area was cut by many small gullies with one large arroyo traversing the entire valley. A large portion of the area suffered from sheet and wind erosion.

The land owners within this area are mostly stockmen, the majority of whom operate on a small scale and a very close margin. Very few farms are seen in this area. These people as a whole cooperated very nicely in working out a program, most of them realizing that the condition of their land was primarily due to overgrazing.

In addition to range improvement and the general conservation of land, it was desirous to work in this locality to study effects of certain treatment on all three types of erosion and to establish demonstration in a locality remote from other conservation work.

This project was started November 1935 and completed in April 1936. The treatment on this area consisted of brush check dams and contour brush spreaders. These spreaders are to act as water spreading structures and also as wind fences.

Mazlini Road:

The Mazlini Road project (No. 20, Plate 4) is located along the northern portion of the Gamado to Mazlini road. The project covers an estimated area of 1,480 acres.

The erosion in this vicinity is moderate sheet combined with numerous gullies, ranging in size from small to large and active gullies. The area is used only as grazing land and is controlled by people living outside the area itself. However, all were anxious to see erosion control practices instituted.

The objective in this particular area was to halt the formation of gullies in their earlier stages of erosion and spread water where possible, thereby hastening the return of the vegetative cover.

This project was started in November 1935 and completed in January 1936. The treatment consisted of a series of brush check dams and several small log diversion and brush spreaders combination structures.

Chin Lee Road:

The Chin Lee Road project (No. 21, Plate 4) is located along the Ganado-Chin Lee-Canyon de Chelly road and covers an estimated area of approximately 305 acres.

The erosion occuring here is mostly sheet erosion and small gullies which cross the road and impair transportation to and from the demonstration area as well as damage the land along the roadway.

The area was started November 1935 and completed January 1935. The treatment consisted of diversion ditches and deflectors to relieve the concentration of runoff due to highway structures.

Fraser Demonstration Area.

The Fraser demonstration area (No. 22, Plate 4) is located approximately 12 miles northwest of Chin Lee, Arizona and includes 5,553 acres. This area is one of the original Soil Conservation Service demonstration areas and was established in April 1934.

No people live within the actual confines of the area itself. Those living in the vicinity who have used it in the past have shown a very cooperative attitude toward the whole program. The people of this locality depend mainly upon their livestock for a livelihood.

The objective in this area was a controlled demonstration of conservation policies. Construction was carried out conforming to engineering and range practices. This included water spreading dikes, gully plugs, water conservation dam, and water development for livestock. Since April 1936 the range management division has had complete charge of the area. Prior to this time the area was restocked according to range control practices, as indicated elsewhere in this report under range improvement.

Lukachukai Area.

The Lukachukai agricultural area (No. 23, Plate 4) is located in a mountain meadow near the summit of the Lukachukai Mountains. This meadow land had been partially destroyed by gully erosion and was completely occupied by the poisonous snoeweed. It is customary for the Indians to pasture their sheep in this vicinity and they therefore welcomed the opportunity of possible agricultural development and the elimination of a poisonous weed.

The principal objective was to determine experimentally the feasibility of snoeweed control by ploughing and seeding to various grasses and cereal crops.

Active work on the project was completed last summer. The methods of control appear to be effective, and it is expected that the Indians will continue to farm this area.

Cove Demonstration Area:

The Cove demonstration area (No. 24, Plate 4) is situated thirty miles south and four miles west of Four Corners. The area extends from the crest of the Lukachukai Mountains to the valley land of the Red Rock Cove. It includes 29,376 acres and is all fenced except for a portion of the western boundary along the mountain divide. The stock have been excluded from the lower area, but difficulty has been encountered in preventing trespass from above. The entire area has been badly damaged by sheet and gully erosion. Grass has been nearly exterminated in many portions of the area and were it not for an open stand of sage brush, chamise and greasewood, much of the area would be entirely bare.

The people living within the area are a thrifty farming population without much in the way of sheep or goats. As all animals have been excluded from the area, it is hard to say what are the real size of the flocks owned by the people living within the area. The Indians have demonstrated a fairly good spirit of cooperation in the preparation of the farm lands and in following the advice of the Agronomists as to the method of farming their land.

The area was chosen as a demonstration area with the idea of showing that the range land could be improved, erosion stopped, and flood irrigation developed for farm land.

The work was started in August 1934 and completed in June 1936. The erosion control work done on the area during the past year has consisted in the plugging of incipient finger gullies, check damming of the smaller arroyos with rock and wire dams, building of earth and rock and wire diversion dams, dikes, and spreader fences. The agricultural work has consisted in the subjugation of 120 acres of farm land, in the rebuilding of the canal and the building of laterals, headgates, intake gates, drops, etc., of the irrigation system in connection with the dam previously built by the Indian Irrigation Service. Two rock and wire diversion dams have been constructed for supplying flood water to outlying and scattered farms. About 100 acres of farm land have been terraced and prepared for flood irrigation. A program of range revegetation and planting of trees and shrubs in the vicinity of structures and in stream beds has been carried out. The area has been turned over to the range management division for restocking.

Highway 666, Area No. 1:

[illegible]

[illegible]

[illegible]

This project (No. 25, Plate 4) is a small fenced area of 61 acres located about five miles south of the Shiprock Indian Agency along the east side of Highway 666. The area consists of a small valley about a quarter of a mile wide, which was being rapidly destroyed by one large gully and several smaller ones. The people in the vicinity appear to be quite favorable toward the work although there has been some difficulty in preventing a few individuals from trespassing with livestock within the area.

The project was originally started by the I.E.C.W. in December 1934. The Soil Conservation Service took over the project in August 1935 and completed it in January 1936. The work consisted in diverting the runoff out of the main wash and by the use of earth dikes and spreader fences of wire and brush, spreading it over the adjacent range land. The area has responded in a remarkable manner to treatment and the improvement in the range has clearly demonstrated the feasibility of this type of work. The area has been turned over to the range management division.

Highway 666, Area No. 4:

An area of 196 acres (No. 26, Plate 4) located ten miles south of the Shiprock Indian Agency along the east side of Highway 666 was fenced in 1934 and livestock were excluded.

Originally started by the I.E.C.W. in December 1934, this project was taken over by the Soil Conservation Service in August 1935. One earth diversion dam was built across the main wash and the diverted water was spread over the adjacent range land. Earth dikes with spreader fences of woven wire and burlap, and wire and brush were built to spread the water. Smaller gullies heading out from the main wash were controlled with earth dikes and check dams of rock and wire. Marked improvement to the range land inside the fence has resulted from the work done. The water spread within the area has affected the range outside the area. The grass at the lower end of the area has receded much of the unfenced portion which was reached by the spread water. This area has been turned over to the range management division.

Shiprock Nursery:

This project (No. 27, Plate 4) aimed to protect the Soil Conservation Nursery near Shiprock from damage from erosion, and is located north of the Battlesnake road about one mile west of the bridge over the San Juan River at the Shiprock Indian Agency. A large gully with a watershed of approximately 1,000 acres empties into the Nursery area and is threatening to wash out the plantings on about 400 acres of Nursery land.

[illegible]

[illegible]

[illegible]

The objective of this work is to protect the Nursery and the planting work within it from being flooded and destroyed. Also to protect the irrigation canal from being washed out.

The work was started in May 1936 and is completed. The work consisted in the constructing of an earth dike and diverting the drainage away from the Nursery area. Rock and wire check dams have been built in the arroyos within the area.

Red Rock Road:

This project (No. 28, Plate 4) lies along the road connecting the Red Rock day school to Highway 666. The project includes the treatment of some 3,425 acres, which have been subject to gully and sheet erosion.

The primary objective of the work carried out was to save the road from being washed out by flood runoff. The work was started in November 1935 and terminated in January 1936. Earth dikes were constructed above head erosion and the runoff conducted to drop structures of rock into the main washes. After the water crosses the road through culverts, it has been diverted out of the washes and spread over adjacent range lands. Rock check dams were built in the smaller washes. Spreader fences of woven wire and brush were built to spread the water over the range land.

Hogback Agricultural Area:

The Hogback Irrigation project developed by the Indian Irrigation Service, includes about 1,160 acres of some of the best farm land on the Reservation. The area is located on the north bank of the San Juan River adjacent to the Shiprock Indian Agency (No. 29, Plate 4).

This valuable farm land has been subject to gullies and sheet erosion from above, and from serious cutting by the meandering San Juan River. The land users were very much interested in this control work and cooperated freely.

The primary objective of this work was to prevent soil depletion on the farm land through improved subjugation and other control methods. The work was started in cooperation with the United States Indian Irrigation Service in November, 1935, and the work was completed in February 1936. Rock and brush jetties were built at strategic points along the north bank of the river and earth dikes were built along the top of the bank to prevent waste irrigation water from cutting the bank. Small gullies were plugged with brush, and assistance was given in the clearing and leveling of 469 acres of newly developed land.

Fruitland Agricultural Area:

On the south side of the San Juan River in the vicinity of Fruitland, the U.S.I.S. is installing an irrigation system which will eventually bring into cultivation about 5,000 acres of land (No. 30, Plate 4). During the past year the main ditches and principal laterals were prepared for delivery of water to approximately 1,000 acres. All this land is subject to erosion damage from the arroyos which start near the top of the mesa escarpment.

The principal objective of this erosion control project was to protect this newly developed land from serious depletion by sheet and gully erosion. The principal gullies were confined in channels or controlled by rip-rap and jetties to prevent cutting into agricultural land.

In cooperation with the U.S.I.S. and with considerable contributed labor on the part of the Indians, the land was rough-levelled, and it is planned that when the work is completed, the irrigation system and the farm land itself will be as nearly erosion proof as possible. Wind breaks were planted to decrease the amount of the rather sandy soil which is being removed by wind erosion.

Land Management Unit No. 14 (Five Chapters):

Land management unit No. 14, as shown on Plate 1, is located north of Gallup and south of a line running east from Washington Pass to the Great Bend of the Chaco. This has been designated as Area No. 31 on Plate 4.

A complete land management study was made of this unit during the winter and the land management program has been initiated. The people in this area are very much interested in the land management development and so far have exhibited a fine cooperative spirit.

The work on this unit was started in March 1936, and to date one diversion dam of earth with a rock masonry core wall has been completed across Mexican Springs Wash. This dam will divert water which will be spread over about 4,000 acres. Two dams are in process of construction. One on the wash south of Drolet's Trading Post and the other on the wash to the north. These two dams will divert water out of the washes and it will be carried in canals to agricultural land for flood irrigation.

The program includes the complete development of all agricultural resources, the proper utilization of forest resources on a sustained yield basis and adjustment of the numbers of livestock to the carrying capacity of the range. Work on this area will be given priority over all other projects so as to hasten the development of the program as rapidly as possible.

Chaco Canyon:

This project (No. 32 Plate 1) lies within the Pueblo Bonito section of the Chaco National Monument, situated about 22 miles north and 10 miles east of the Crown Point Indian Agency. This area of 16,000 acres has been fenced by the National Park Service and all stock excluded. About 3,000 acres of this fenced area have been treated under this project.

The work was started in November 1935 and is about 85 percent complete. The work on the banks of the main arroyo consists of earth dikes which divert the water that pours off the perpendicular cliff walls of the canyon and conduct it into the main wash over masonry drop structures. The road connecting the ruins has been protected against erosion from the small arroyos that it crosses by means of rock and woven wire check dams. One diversion dam of earth has also been constructed; the road now passes over the dam and the water is diverted and spread by means of an earth dike, with wire and brush fences placed below the spill end of the dike. Serious head erosion taking place in a side canyon has been stopped by diverting a portion of the runoff by means of an earth dike and spreading it over an adjacent grass flat, the remainder of the runoff has been spilled into the arroyo over a masonry drop structure. The work within the main arroyo consists of woven wire fences suspended by cables across the coves formed by the meandering of the wash. Post and woven wire fences have been built from the suspended cable to the bank. Rock and wire jetties have been placed in order to deflect the current away from threatened parts of the banks. A rock and wire wall has been built in the stream bed in order to retain the bank on which one of the larger ruins is located. The work has been carried out in conformity with the views of the Park Service. Rodent control work has been done in the vicinity of earth structures. Trees and shrubs have been planted in the stream along the banks and on deltas. Denuded areas on the banks have been seeded to grass.

Kinbiniolí:

This project (No. 33 Plate 1) lies about 6 miles east of Crown Point Indian Agency on the east fork of the Kinbiniolí Wash. It was started as a cooperative project with the I.E.C.W. and 307 acres were fenced and stock excluded. The project offered an excellent opportunity to demonstrate proper range control as both gully and sheet erosion were threatening the area.

The work on this area was started in December 1934. An earth diversion dam was built by the I.E.C.W. Upon completion of

the dam work was dropped by the I.E.C.W. The Soil Conservation Service took over the project in August 1935 and completed it in January 1936.

The small finger gullies at the south end of the area were plugged with rock dams, small check dams of rock were constructed in small washes, diversion dikes of earth were built to divert water from the larger gullies and spread it by means of spreader fences over the adjacent range. The water, after it was spread, was allowed to find its way to the reservoir behind the dam constructed by the I.E.C.W. The water spilling from the reservoir is again spread by means of earth dikes and spreader fences, and finally finds its way into a farm plot at the north end of the area. Range conditions have so improved that the Indians are now using the area as a hay meadow.

Marinna Lake:

Marinna Lake Demonstration Area (No. 34 Plate 4) is situated 1½ miles due southwest of Crown Point Indian Agency. It was selected as one of the original working areas of the Navajo Project and an area of 7,005 acres was fenced. The area is cut through the center by a large arroyo which carries the entire runoff out of the area. Fifteen good size arroyos drain the south slopes and some 20 large and fair sized arroyos drain the north slopes into the main arroyo. The washes on the south slopes have cut down to bed rock, while those coming from the north, although not down to bed rock, are of a greater depth.

The primary objective of the work on this area was the demonstration of erosion control, range improvement, and flood irrigation farming.

The fencing of the area was started in May 1934, erosion control and other work in June 1934, and the project was completed, except for maintenance, in June 1936. The work during the period June 1935-June 1936 consisted in the constructing of earth diversion dams and dikes with spreader fences of woven wire and burlap. Gully plugging in the upper part of the watershed of the northwest portion of the area was completed. Small rock check dams were built in the feeders of the larger arroyos on the northwest part of the area. The area was divided longitudinally by a barbed wire fence for the better handling of an experimental herd of cattle placed on the area. A portion of the main arroyo in which water is impounded by a dam and which had become a bog was fenced to prevent cattle from having access to the water behind the dam. The flood irrigated farm area has been fenced. A seep in an arroyo

was developed and water impounded behind a masonry dam for stock use. The area has been turned over to the Range Management Division for administration, as explained elsewhere in this report under Range Improvement.

Special Erosion Project No. 10:

This Special Erosion Project No. 10 (No. 35 Plate 4) is located along the east side of the Mariano Lake-Crown Point road about midway between the two places. It is estimated that approximately 100 acres have been affected by the work undertaken on this project. The road was seriously threatened at this point by several gully fingers eating back towards the road. The primary objective of the work was, therefore, the prevention of head erosion. The work was started in January 1936 and concluded in June of the same year and consisted of one large masonry drop structure with training dikes built above several heads for the purpose of diverting the water to this one central structure.

Kinlichee Special:

This project (No. 36 Plate 4) was located approximately 2 miles north and west of Kinlichee on a small watershed, which empties directly into the Pueblo Colorado Wash. The area treated contains approximately 2,450 acres. The erosion on this area is of two types - moderate sheet erosion and gully erosion varying from slight fingering to some very large and active heads.

The land owners within this area are mostly sheep owners, although a few small well cared for farms are found throughout the area. The residents of this area have cooperated very nicely and have on several occasions expressed a desire to have a fenced demonstration area with enforced grazing control.

The objective in this particular community was to stabilize the existing gullies, to prevent new gullies, and at the same time give work to a community which was anxious to cooperate in a range improvement program.

This project was started in November 1935 and completed in March 1936. The entire area was treated with brush in the form of check dams and spreaders. A few large log dams were constructed to be used as stabilizers and one small earth water conservation dam was constructed.

Steamboat Canyon - Canado Road:

This project (No. 37 plate 4) is located along the road from Canado to Steamboat, and includes an estimated area of 2,040 acres. The project is worked cooperatively with the County Road Commissioners of Apache County who furnished tractor and grader. This portion of the road was under heavy use by the Soil Conservation Service because of the Steamboat Demonstration Area and the objective was to facilitate the transportation problem, as well as to stabilize gullies and spread water over adjacent range lands.

The road traverses a country which is badly cut by the gullies and the road bed was washed out in many places. The above-mentioned gullies are all active not only in the destruction of the country they traverse but to the roadway as well.

The project was started in November 1935 and closed down in March 1936 with approximately 640 acres completed. A temporary grade was made to Steamboat. Several rock crossings and dips were constructed as well as water spreading dikes and spreader fences.

Steamboat Canyon:

The Steamboat Canyon Demonstration Area (No. 38 Plate 4) is located about 25 miles due west of Canado, Arizona. The area, consisting of approximately 25,000 acres, has been fenced for some time, but because of delay in water development it has not been possible to exclude stock until recently. One large arroyo runs through the center of the area with numerous smaller gullies entering the main wash from both sides.

The Indians living within the area have shown a splendid spirit of cooperation. All the labor on the farm area has been donated except for such as was done with a small tractor. The farm land has been subjugated under the supervision of, and according to the ideas of the Soil Conservation Service.

The primary objective of the work is to demonstrate the rehabilitation of the range by proper methods of erosion and grazing control and by the spreading of flood water over the range. Farm land developments for flood irrigation has been demonstrated.

The project was started in August 1935 and is about 85 percent complete. The entire area was fenced and the camp constructed during the first months of work. About 6,146 acres have been treated for gully control with small brush and log plugs. The larger feeder gullies have been check dammed with rock and brush dams.

Roads have been built for better access to the various work sites. One diversion dam of earth has been built with suitable diversion dike and spreader fences of woven wire and brush, spreading water over several acres of valuable range land. Smaller dikes have been constructed across washes and the water spread over adjacent range land. About 40 acres of farm land has been subjugated and made ready for flood irrigation. Headgates, checks, intake gates, etc. of masonry have been built in the canals and laterals. About 70 acres of range land have been treated for noxious weed control.

Klag-E-Toh:

The Klag-E-Toh Demonstration Area (No. 39 Plate 4) is located in the Klag-E-Toh Valley east of the Klag-E-Toh Trading Post and directly below the Indian Irrigation Service dam. It extends down the valley approximately 7 miles and includes the entire drainage on the western slope, as well as the valley floor itself, embracing 3,899 acres.

The people residing within this area obtain their livelihood through a combination livestock and agricultural enterprise. The valley floor consists of very fertile agricultural land, while the remainder of the area is used for range purposes. The range land is threatened through moderate sheet and gully erosion.

The inhabitants have cooperated both through the period of construction and since the work has been completed. In the subjugation and construction of canals teams were donated by the land owners.

Sunrise Road:

This project (No. 40 Plate 4) is located along the road from Sunrise to Canado, Arizona, with an estimated treated area of 665 acres. Moderate sheet erosion and gullying occur along each side of the roadway as well as several large gullies which cross the road, one being the Pueblo Colorado Wash.

The owners along the road were very cooperative toward this project. Teams used on this project were donated by persons along the roadway who were employed on the project. Government employees and people traveling from Canado to Sunrise were well pleased with both the erosion control work and the road improvement.

The objective of this project was to control the erosion along the roadway and at the same time facilitate transportation.

This project was started in December 1957 and completed in February 1959. The type of instrument employed consisted of two accelerometers of large physical size, strong and large long range and were characterized by good level with the failure of the pendulum in instruments and no power on accelerometer.

Results

Results accelerometers were (Fig. 11 Table 1) in one of the artificial work areas selected for the purpose of demonstrating proper land measurements. It is limited measurements of levels, failures to the speed, size of the levels otherwise long and accelerometer equipment by (1) access, which can fixed. The area is dependent of measurements by the velocity and is subject to measure about and daily operations.

The people failure within this area are engaged in both industrial related and agricultural production and in a whole are fairly prosperous. They have established a very cooperative spirit toward the planning and execution of a land measurement program on this area.

Conclusions are charged on this area in April 1959 and was completed May 1, 1959 and the area overall over the area accepted criteria for the execution of further evaluated pilot plan. Problems on this area developed in the measurements of small dairy farms, such clients and farms, workers clients, systems farms, installations, agricultural development, and measure farms of planning. This area was previously committing to study involved problems in September with prior to the completion of accelerometer in April 1959.

Fig. Illustration

This project (Fig. 12 Table 1) is situated within the Lignite area of N. Dakota, Dakotas. The barrel accelerometer area have been formed and which has been completed. The large acreage and barrel small farms are characterized relatively active and work-oriented farms.

The farmers this have participated in the pilot work. Fig. accessible for the farms, which charge and charge such farm have been supplied by the farm owners.

The main objectives of the work was the charging of measure water for irrigation purposes. This farm, however, will have a hydraulic access on Indian lands further investigation as the accepted land in the irrigation purposes. This work was started in May 1959

gullies while the land in the valley contains several larger washes.

The land owners in this locality have entered very heartily into the conservation of their range, as well as the agricultural land in the valley.

The objective of the treatment in this particular locality was to check the flingering above the farm land and to prevent the rushing of water into the farm land which was causing considerable gullying.

This project was started in November 1935 and by January 1936, when it was closed down, 3,885 acres of the original 5,500 had been treated. The treatment for this area consisted of brush check dams and spreaders as well as a few small earth dikes and loose rock checks.

Navajo Agency:

This project (No. 15 Plate 4) includes the local drainage at the Navajo Agency and covers an area of approximately 639 acres. The erosion on this area consists of moderate sheet, gully, and wind erosion.

The objective of the treatment within this area was to protect the existing vegetation, to revegetate where possible, to control wind erosion, and to utilize all runoff on the area as much as possible.

This area was started in November 1935 and was varied rather intermittently due to lack of labor which was required for other construction carried on in the vicinity. The treatment employed on this area has consisted of brush check dams and gully plugs, brush and wire spreaders, a few masonry checks, a small amount of brush wind control barriers, and two water conservation dams which were turned over to the U.S.I.I.S. and the B.C.W. for construction. Construction is still being carried on in this area.

Concho Cooperative Area:

This demonstration cooperative area (No. 16 Plate 4) comprising about 3,500 acres of which 400 acres are agricultural land, lies 15 miles west of St. Johns, Apache County, Arizona. Concho Creek, which bisects the area, is fed by large permanent springs which furnish the irrigation water for the land within the area.

and is 90 percent complete. Three old log crib dams were repaired in the main arroyo, one rock masonry dam was constructed in a wash that has a small perennial flow. The flow was diverted by means of this dam into a canal which irrigates a small farm. A canal with suitable checks and gates was constructed. The smaller washes have been check dammed with small rock and brush dams. The wash has been planted with shrubs and trees to further widening of the stream.

Special Erosion Project No. 15:

Special Erosion Project No. 15 (No. 15 Plate 4) is located along the east side of the Hiap-B-Toh demonstration area and extends from the east side of the area back to the top of the divide along the entire length of the area, excluding the watershed of one particular drainage which the irrigation canal, referred to later in this report, crosses by means of a syphon.

The area includes approximately 6,130 acres. The slope of this particular area is relatively steep over most of the area and is cut by numerous gullies ranging from small headers to well formed channels. While the majority of these are not large, they carry considerable water and silt which is particularly detrimental to the irrigation canal below.

This area is used entirely for grazing. However, most of the people who use this area have some farm land under the irrigation ditch directly below the area and were very anxious to have protection in this locality, and a spirit of hearty cooperation existed. While the main objective of all erosion control work is soil conservation and range improvements, this project carried in addition the special feature of protection of the irrigation canal directly below the area which runs at a right angle to the drainage.

This project started February 1936 and closed in April 1936 after treatment had been completed on some 1,800 acres. This treatment consisted of brush plugs and check dams along with a few diversion and brush spreaders.

Oak Springs:

This project (No. 14 Plate 4) is located approximately 30 miles south of St. Michaels, Arizona in a small drainage carrying into Black Creek and covers an area of approximately 9,550 acres. The upper part of the area is very badly cut by numerous

Erosion conditions are extreme in portions of the area, particularly on the steep slopes of the adjacent rolling hills, and in the flat bottom lands lying adjacent to the main creek and its tributaries. A large portion of the erosion in the bottom lands is directly due to the improper handling of excessive irrigation waste water which is augmented from time to time by precipitation runoff.

The attitude of the approximately 600 people of this area was more or less phlegmatic prior to the taking over of the area, but with the coming of the work which gave some of them a means livelihood their spirit of cooperation has been very good, particularly when they were asked for the donation of materials and they were able to furnish some. At present, with the aid given them, some have been able to carry on personally on their small farms for the first time in two or three seasons.

The primary objective to be accomplished in this area has been to overcome the excessive erosion as much as possible, first by establishing range control, and second by the construction of structures which will retard and control or spread the runoff, thereby checking erosion and farm land devastation.

Good progress has been made on the area to date and work has been carried on in the area or portions thereof where erosion control was considered most critical.

Much work was planned on a rehabilitation of the irrigation ditch or distribution system. However, this portion of the planned work has been held in abeyance awaiting some Resettlement Service plans for the area. One fairly large earth fill dam has been constructed to be used as an equalizing reservoir to hold back temporarily flood runoff which has heretofore carried large quantities of silt down into the Kenyo Reservoir to such an extent that its usefulness has been almost overcome. Many other minor structures have been completed or are now under construction.

A general statistical summary of the work is as follows:

> About 9.25 miles of fence has been built to facilitate range control. Of this, about 75 percent of the material was contributed.
>
> Structures of earth construction involved the handling of about 3,350 cubic yards.
>
> Structures of rock construction involved the handling of about 200 cubic yards.

An estimate of the acreage benefitted by the work accomplished in the area to date is about 1500 acres.

Farmington Reservoir Area:

This project (No. 47, Plate 4) was selected because of the urgent need of protecting the watershed about the city reservoir from severe erosion and runoff caused by the torrential summer rains to which the area is subjected. The project, being the first selected in the locality, is valuable as a demonstration area.

The drainage taken under control consists of 607 acres. The topography of the area is undulating, being divided into two main drainages which converge into one main arroyo approximately 350 feet above the highwater line at the point of entering the city reservoir. Each drainage is broken into many small tributaries.

The principal plants on the area are galleta, blue grama, three awn, and sunflower, juniper and pinon trees. The average density of the forage is estimated to be three-tenths.

The area has been heavily overgrazed. However, the cooperators have agreed to total exclusion. It is suggested that the area be resurveyed in 1937 and that stock be admitted to the carrying capacity at that time.

The soils are generall of light texture, loam and sandy loam predominating.

A ten year average given by the U. S. Weather Bureau for Farmington, New Mexico shows an average precipitation of 8.94 inches per year with a low of 4.41 inches and a high of 10.82 inches.

The work accomplished from March 2 until June 30 is listed below. This practically completes everything contemplated at this time.

14	brush spreader fences aggregating	1,267 lin. ft.
9	earth diversion dikes aggregating	2,372 lin. ft.
47	rock and wire dams aggregating	1,336 lin. ft.
23	loose rock check dams aggregating	637 lin. ft.
2	dams, stock water tanks, aggregating	170 lin. ft.
12	diversion ditches, for spreading, aggregating	3,086 lin. ft.
3256	rock and gulley plugs	
1	rock and wire revetment wall 4' x 4' x 52'	
1	special overshot structure containing 1,673 cubic yards of boulder rock, 171 cubic yards earth.	

Planting:

5,070 wolf brush plants
5,040 cliff rose plants
50 plum trees
8 cottonwood trees
3,200 pounds western wheat grass - 200 acres
100 panicum obtusum

A total of 2,105 man days employed on this area.

The cooperators furnished 35 linear feet of 30 inch corrugated metal culvert, 30 sacks Portland cement, and the majority of the brush used in the check dams, the material being prunings from adjacent orchards.

Star Irrigation Canal Project:

The meandering of the Glade Arroyo at the point of crossing of the Star ditch being of such a nature as to threaten the company flume and weir, or outlet, abutment and approximately 75 linear feet of the canal induced the selection of this project (No. 16 plate 4).

This project is strictly one of protection for a flume and canal which serves an area of approximately 75 acres intensely cultivated, being largely set to fruit. The area of the Glade arroyo watershed is 22,716 acres.

The topography of the agricultural land is gently sloping and is fully subjugated. The topography of the Glade Arroyo shows a long narrow valley with side slopes ranging from 0 to 10 percent. The agricultural lands served by the canal are fully covered by alfalfa, orchards and small fruits. The cover on the Glade arroyo consists principally of blue grass, galleta, wheatgrass, three awn, sage brush, mountain mahogany, bitter brush, and pinyon.

The watershed has been exceedingly overgrazed. Cattle have run year long on a portion of the area and sheep have been run over the balance during the winter. It is anticipated that range control will be obtained over this entire watershed and that careful treatment will be undertaken.

The soils of the agricultural areas are largely sandy loam. The same is true of the Glade watershed except that some portions probably run somewhat heavier.

Work was first started March 16 and was completed May 9. No additional work is contemplated on the flume protection project at this time. Work done is itemized as follows:

1 rock and wire sausage 3' X 4' X 200'
2 rock and wire sausage 6' X 8' aggregating 90'
1 loose rock dike 4' X 6' X 51'
1 revetment fence 4' high, 200' long
1 wood tray 4' high, 300' long

A total of 294 man days was employed.

Plantings: 296 cottonwood trees.

The cooperator furnished 300 linear feet of 4' galvanized woven wire, 42 juniper posts 7 feet long, and 300 cottonwood trees for planting.

North Farmington Canal Protection Project:

Due to the tendency of the storm waters in the Glade arroyo to undermine and destroy a large portion of the 300 foot company flume, this protection project was selected. (No. 40 plate 4).

The area served by that portion of the North Farmington ditch beyond the Glade arroyo is approximately 1,000 acres. The area of the Glade arroyo watershed is 22,716 acres. The topography is similar to that previously described under the Star Ditch report.

The work accomplished between May 25 and June 30 is as follows: Construction 310 linear feet of rock and wire revetment 4 feet wide and 8 feet high, thoroughly cabled together and the construction of a diversion channel 5' X 20' X 300'. A total of 772 man days were used.

The following materials and supplies were furnished by the cooperators:

4" square mesh wire	125 rods
3/4" cable	500 linear feet
1/2" cable	700 linear feet
Cable clips	96
12' juniper posts	70
Tie wire	500 pounds
Brush (approximately)	200 truck loads

Lower Animas Canal Protection Project (Knickerbocker Arroyo):

The Knickerbocker arroyo, an ephemeral stream, subject to high floods, caused by torrential rains on its watershed, seriously threatened th destroy the 5 foot diameter wood stave inverted siphon which passed the Lower Animas ditch across the stream bed. Heavy bank cutting into improved agricultural lands and the threat to destroy a residence and other improvements influenced the selection of this work project. (No. 50 plate 4)

This job is strictly one of protection. The area of the agricultural lands served by that portion of the Lower Animas ditch below the Knickerbocker arroyo watershed is 6,560 acres. The topography of the agricultural lands under the Lower Animas ditch is gently sloping toward the Animas river. The topography of the Knickerbocker arroyo watershed is undulating hills.

The agricultural lands are covered by diversified farms and orchards. The area contains the town of Aztec, New Mexico. The cover of the Knickerbocker arroyo drainage is principally blue grass, gallota, wheatgrass, and three awn, sagebrush, mountain mahogany, bitterbrush, and pinyon.

The past use has been to seriously overgraze the entire watershed. A few cattle have been kept on the area. However, sheep have used the area to the greatest extent.

It is expected that complete range control of the area my be obtained following which treatment to prevent heavy runoff and erosion would be undertaken.

Soils over the entire area are generally light, sandy loam predominating.

The Knickerbocker arroyo watershed receives some snow during the winter months. The average yearly precipitation at Aztec is taken at 8.5 inch. Nine inches is considered a fair estimate for the area.

The work job was started May 11 and completed June 30. The work consisted of the following:

Placing 8 log, brush, and rock cribs averaging 20' X 20' X 8'.

Placing 700 linear feet of wire, brush, and rock revetment wall 8 feet high, 4 feet wide.

A total of 609 man days was used.

The cooperators supplied the following items:

Cottonwood logs 20 feet long	239	
Juniper posts 12 feet long	73	
Steel cable 3/4 inch	1,400	linear feet
Drift pins 5/8" x 18"	150	
Tie wire	550	pounds
Staples	15	pounds
Cable clips	16	
Lumber	134	Board feet
Square mesh wire 32 inch	130	rods
Brush (large truck loads)	124	loads
Teams	40	team days

Working relations with all cooperators have been very pleasant and they have been generous in their expressions of appreciation for the Soil Conservation Service interest and have been very complimentary regarding the quality of work done.

Coyote Creek Area:

This area (No. 51 plate 4) lies four miles east of Springerville, Arizona next to New Mexico state line on upper headwaters of Coyote Creek adjoining the Apache National Forest. It is in townships 8 and 9 north, ranges 30 and 31 east, and includes some 33,000 acres.

Erosion has resulted in a considerable gullying on Coyote Creek and tributaries and though it is not a serious problem at present, it is in need of attention. There are a few reservoirs on lower Coyote Creek and Little Colorado river which are silting from this watershed.

Stockmen on this area (which is strictly range land) are at present practicing creditable grazing systems and were favorable to control measures being inaugurated. Most owners seemed in fair to good circumstances.

The primary objective was to establish range control and halt erosion of range lands through proper range and woodland management.

A range and erosion survey has been made in conjunction with a plane table map survey of the area. Because of shortage of labor in the vicinity and some hesitancy on the part of the cooperators to sign up, further action on this area has been temporarily postponed.